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Application Guideline and Service Manual

NOTE: Read the entire instruction manual before starting the installation.

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40px;">Final Check-Out35</p> <p style="padding-left: 20px;">Desert and Seacoast Locations.....35</p> <p>APPENDIX36</p> <p style="padding-left: 40px;">SAFETY CONSIDERATIONS</p> <p style="padding-left: 60px;">Installation, service, and repair of these units should be attempted only by trained service technicians familiar with standard service instruction and training material.</p> <p style="padding-left: 60px;">All equipment should be installed in accordance with accepted practices and unit Installation Instructions, and in compliance with all national and local codes. Power should be turned off when servicing or repairing electrical components. Extreme caution should be observed when troubleshooting electrical components with power on. Observe all warning notices posted on equipment and in instructions or manuals.</p>
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Manufacturer reserves the right to discontinue, or change at any time, specifications or designs without notice and without incurring obligations.

⚠ CAUTION

Puron® (R-410A) systems operate at higher pressures than standard R-22 systems. Do not use R-22 service equipment or components on Puron® equipment. Ensure service equipment is rated for Puron®.

Refrigeration systems contain refrigerant under pressure. Extreme caution should be observed when handling refrigerants. Wear safety glasses and gloves to prevent personal injury. During normal system operations, some components are hot and can cause burns. Rotating fan blades can cause personal injury. Appropriate safety considerations are posted throughout this manual where potentially dangerous techniques are addressed.

INTRODUCTION

Section 1 of this Application Guideline and Service Manual provides the required system information necessary to install Puron® equipment in all applications. Section 2 provides the necessary information to service, repair, and maintain the family of Puron® air conditioners and heat pumps. Section 3 of this manual is an appendix. Use the Table of Contents to locate desired topics.

INSTALLATION GUIDELINE

Step 1—Residential New Construction

Specifications for this unit in the residential new construction market require the outdoor unit, indoor unit, refrigerant tubing sets, metering device, and filter drier listed in Product Data Digest (PDD). **DO NOT DEVIATE FROM PDD.** Consult unit Installation Instructions for detailed information.

Step 2—Add-On Replacement (Retrofit)

Specifications for this unit in the add-on replacement/retrofit market require change-out of outdoor unit, metering device, and all capillary tube coils. Change-out of indoor coil is recommended. There can be no deviation.

1. If system is being replaced due to compressor electrical failure, assume acid is in system. If system is being replaced for any other reason, use approved acid test kit to determine acid level. If even low levels of acid are detected install factory approved, 100 percent activated alumina suction-line filter drier in addition to the factory supplied liquid-line filter drier. Remove the suction line filter drier as soon as possible, with a maximum of 72 hr.
2. Drain oil from low points or traps in suction-line and evaporator if they were not replaced.
3. Change out indoor coil or verify existing coil is listed in the Product Data Digest.
4. Unless indoor unit is equipped with a Puron® approved metering device, change out metering device to factory-supplied or field-accessory device specifically designed for Puron®.
5. Replace outdoor unit with Puron® outdoor unit.
6. Install factory-supplied liquid-line filter drier.

⚠ WARNING

Never install suction-line filter drier in the liquid-line of a Puron® system. Failure to follow this warning can cause a fire, personal injury, or death.

7. If suction-line filter drier was installed for system clean up, operate system for 10 hr. Monitor pressure drop across drier. If pressure drop exceeds 3 psig, replace suction-line and liquid-line filter driers. Be sure to purge system with dry nitrogen and evacuate when replacing filter driers. Continue to monitor pressure drop across suction-line filter drier. After 10

hr of runtime, remove suction-line filter drier and replace liquid-line filter drier. **Never leave suction-line filter drier in system longer than 72 hr (actual time).**

8. Charge system. (See unit information plate.)

Step 3—Seacoast (For Air Conditioners Only)

Installation of these units in seacoast locations requires the use of a coastal filter. (See section on cleaning.)

ACCESSORY DESCRIPTIONS

Refer to Table 1 for an Accessory Usage Guide for Puron® Air Conditioners and Table 2 for Puron® Heat Pumps. Refer to the appropriate section below for a description of each accessory and its use.

Compressor Crankcase Heater

An electric heater which mounts to base of compressor to keep lubricant warm during off cycles. Improves compressor lubrication on restart and minimizes chance of refrigerant slugging and oil pumpout. The crankcase heater may or may not include a thermostat control. For units equipped with crankcase heaters, apply power for 24 hr before starting compressor.

Crankcase Heater Switch

Some models may contain a crankcase heater switch (CHS). The switch is used to control the crankcase heater. It closes on a temperature fall and completes the circuit to the compressor crankcase heater. The CHS closes at 65°F and opens at 85°F, ambient temperature.

Evaporator Freeze Thermostat

An SPST temperature activated switch stops unit operation when evaporator reaches freeze-up conditions.

Winter Start Control

An SPST delay relay which bypasses the low-pressure switch for approximately 3 minutes to permit start up for cooling operation under low-load conditions.

Compressor Start Assist—PTC

Solid-state electrical device which gives a “soft” boost to the compressor each start.

Compressor Start Assist-Capacitor/Relay

Start capacitor and start relay gives “hard” boost to compressor motor at each start. Required with Liquid Line Solenoid or hard shutoff TXV for all Series A equipment.

MotorMaster® Control

A fan speed control device activated by a temperature sensor. It is designed to control condenser fan motor speed in response to the saturated, condensing temperature during operation in cooling mode only. For outdoor temperature down to -20°F, it maintains condensing temperature at 100°F ± 10°F. Requires a ball bearing fan motor.

Low-Ambient Pressure Switch

A long life pressure switch which is mounted to outdoor unit service valve. It is designed to cycle the outdoor fan motor in response to condenser pressure in cooling mode in order to maintain head pressure within normal operating limits (approximately 200 psig to 365 psig). The control will maintain working head pressure at low-ambient temperatures down to 0°F when properly installed.

Wind Baffle

A field-fabricated sheet metal cover used to stop prevailing winds or where outdoor ambient temperature is less than 55°F during unit operation of cooling mode.

Coastal Filter

Table 1—Required Field-Installed Accessories for Puron® Air Conditioners

ACCESSORY	ORDERING NUMBER	REQUIRED FOR LOW-AMBIENT APPLICATIONS (BELOW 55°F)	REQUIRED FOR LONG-LINE APPLICATIONS (50-175 FT)	REQUIRED FOR SEACOAST APPLICATIONS (WITHIN 2 MILES)
Crankcase Heater	KAACH1201AAA	Yes	Yes	No
Evaporator Freeze Thermostat	KAAFT0101AAA	Yes	No	No
Winter Start Control	KAAWS0101AAA	Yes	No	No
Compressor Start Assist—PTC or Compressor Start Assist—Capacitor/Relay	‡	Yes	Yes	No
MotorMaster® Control or Low-Ambient Pressure Switch	32LT660004 (RCD)* or KSALA0301410	Yes	No	No
Wind Baffle	N/A	Yes	No	No
Coastal Filter	KAACF0201MED or KAACF0701SML	No	No	Yes
Support Feet	KSASF0101AAA	Recommended	No	Recommended
Puron® Hard Shutoff TXV	KSATX0201HSZ KSATX0301HSZ KSATX0401HSZ KSATX0501HSZ	No	Yes	No

*Fan motor with ball bearings required.

‡Consult Product Data Digest for appropriate ordering number.

Table 2—Required Field-Installed Accessories for Puron® Heat Pumps

ACCESSORY	ORDERING NUMBER	REQUIRED FOR LOW-AMBIENT COOLING APPLICATIONS (BELOW 55°F)	REQUIRED FOR LONG-LINE APPLICATIONS (50–175 FT)
Crankcase Heater	KAACH1201AAA	Yes	Yes
Evaporator Freeze Thermostat	KAAFT0101AAA	Yes	No
Compressor Start Assist—Capacitor and Relay	‡	Yes	Yes
MotorMaster® Control or Puron® Low-Ambient Pressure Switch	KSALA0301410	Yes	No
Wind Baffle	N/A	Yes	No
Support Feet	KSASF0101AAA	Recommended	No
Puron® Hard Shutoff TXV	KSATX0201HSZ KSATX0301HSZ KSATX0401HSZ KSATX0501HSZ	Yes*	Yes*
Puron® Liquid-Line Solenoid Valve for Heating	KHALS0401LLS	No	Yes
Isolation Relay	KHAIR0101AAA	Yes	No

*Required for all applications.

‡Consult Product Data Digest for appropriate ordering number.

A mesh screen inserted under top cover and inside base pan to protect condenser coil from salt damage without restricting air-flow.

Support Feet

Four adhesive plastic feet which raise unit 4 in. above mounting pad. This allows sand, dirt, and other debris to be flushed from unit base; minimizes corrosion.

Liquid Line Solenoid Valve

An electrically operated shutoff valve to be installed at outdoor or indoor unit (depending on tubing configuration) which stops and starts refrigerant liquid flow in response to compressor operation. Maintains a column refrigerant liquid ready for action at next compressor operation cycle.

Thermostatic Expansion Valve

A modulating flow control device which meters refrigerant flow rate into the evaporator in response to the superheat of the refrigerant gas leaving the evaporator. Puron® TXVs are hard shutoff only. Only use factory specified TXVs.

LOW-AMBIENT GUIDELINE

The minimum operating temperature for these units in cooling mode is 55°F outdoor ambient without additional accessories. This equipment may be operated in cooling mode at ambient temperatures below 55°F when the accessories listed in Table 1 or 2 are installed. Wind baffles are required when operating in cooling mode at ambients below 55°F. Refer to Fig. 1 and 2, and Tables 3 and 4, for wind baffle construction details. Puron® Two-Speed units are not approved for low ambient operation.

LONG-LINE GUIDELINE

This guideline provides the required system changes for the Puron® air conditioners and heat pumps having piping requirements greater than 50 ft or installations where indoor unit is located above and/or below outdoor unit, by more than 20 ft. This guide is intended to cover applications outside Installation Instructions.

All air conditioners and heat pumps require a hard shutoff TXV, a compressor start capacitor and relay, and a crankcase heater in long-line installations.

Step 1—Interconnecting Tubing

Table 4 lists the required interconnecting vapor line diameters for heat pumps. Puron® systems installed in long-line applications must use **only 3/8-in. liquid lines**. Equivalent line lengths equal the linear length (measured) of the interconnecting vapor tubing plus losses due to elbows. (See Table 7 and Fig. 4.) Table 6 provides estimated percentage of nominal cooling capacity losses based on standard required vapor line size versus what is selected for long-line application.

Refer to outdoor unit presale literature for the required vapor line diameter.

Calculate linear length of vapor tube required, adding any losses for total number of elbows for application. (See Table 7.) Using this equivalent length, select desired vapor line size from the table. Subtract nominal percentage loss from outdoor unit presale literature Detailed Cooling Capacities for given indoor/outdoor combination. Reference all notes of Table 6.

NOTE: When specifying the vapor line insulation, be aware of the following standard practice.

Tubing kits should meet the following recommendations to minimize losses through insulation: 5/8-in. and 3/4-in. tubing kits should be supplied with 3/8-in. insulation; 7/8-in. and 1-1/8-in. tubing kits should be supplied with 1/2-in. insulation. For minimal capacity loss in long-line application, 1/2-in. insulation should be specified.

NOTE: Special consideration must be given to isolating interconnecting tubing from building structure. Isolate tubing so that vibration or noise is not transmitted into structure. (See Fig. 3.)

Step 2—Metering Device-Long Line Set

A hard shutoff TXV must be used instead of a piston for an indoor metering device. When sizing an accessory TXV, refer to unit presale literature.

NOTE: With heat pumps having vertical or equivalent lengths over 100 ft, the outdoor piston size **MUST** be increased one size.

A liquid-line solenoid must be used for all long-line heat pump applications. The solenoid valve has a flow arrow stamped in the valve body. This flow arrow must point toward the outdoor unit.

Step 3—Tubing Configuration

Fig. 5 through 7 detail the proper installation of equipment and provide applications where accessories may be required. Reference all notes of appropriate figure.

Step 4—Charging Information

Use subcooling charging method. The standard subcooling charging methods can be found in refrigerant system charging section of Service Manual. Since total system charge is increased for long-line application, it is necessary to calculate additional refrigerant charge. The rating plate charge of a given outdoor unit is for a standard application of 15 ft of interconnecting tubing. For line lengths greater than 15 ft, add 0.60 oz of refrigerant per foot of additional line length. The rating plate charge can be found on outdoor unit rating plate or in the outdoor unit presale literature. Long-line applications do not require additional oil charge.

NOTE: Excessive charge will increase risk of refrigerant migration and compressor damage. Charging units with long refrigerant lines must be done carefully to avoid over-charging. Pressure and temperature changes are slower with long lines. Adding or removing charge must be done slowly to allow time for system to stabilize.

UNIT IDENTIFICATION

⚠ WARNING

Improper installation, adjustment, alteration, service, maintenance, or use can cause explosion, fire, electrical shock, or other conditions which may cause personal injury, death, or property damage. Consult a qualified installer, service agency or your distributor or branch for information or assistance. The qualified installer or agency must use factory-authorized kits, accessories, or replacement components when modifying this product.

Troubleshooting Charts for Puron® Air Conditioners and Heat Pumps are provided in the appendix at back of this manual. They enable the service technician to use a systematic approach to locating the cause of a problem and correcting system malfunctions.

This section explains how to obtain the model and serial number from unit rating plate. These numbers are needed to service and repair the Puron® air conditioner or heat pump.

Step 1—Model Number Nomenclature

Model number is found on unit rating plate. (See Fig. 8 and 9.)

Step 2—Serial Number Nomenclature

Serial number is found on unit rating plate. (See Fig. 8 and 10.)

CABINET ASSEMBLY

Certain maintenance routines and repairs require removal of cabinet panels.

Step 1—Remove Top Cover

1. Turn off all power to outdoor and indoor units.
2. Remove access panel.
3. Remove information plate.
4. Disconnect fan motor wires and cut wire ties. Remove wires from control box. Refer to unit wiring label.
5. Remove screws holding top cover to coil grille and corner posts.
6. Lift top cover from unit.
7. Reverse sequence for reassembly.

Step 2—Remove Fan Motor Assembly

1. Perform items 1 through 6 from above.
2. Remove nuts securing fan motor to top cover.
3. Remove motor and fan blade assembly.
4. Reverse sequence for reassembly.
5. Prior to applying power, check that fan rotates freely.

Step 3—Information Plate

The information plate is secured to front of control box and provides the control box cover. (See Fig. 11.) This plate also provides a surface to attach the wiring schematic, superheat charging tables with instructions, and warning labels. The plate has 2 tabs on top edge that are bent down at slightly more than 90°. When information plate is removed, these tabs can be inserted into 2 mating slots in bottom front edge of control box and plate will hang down forming a lower front panel. (See Fig. 12.) This is convenient when access to controls is required while unit is operating. The information plate on small size casing completely

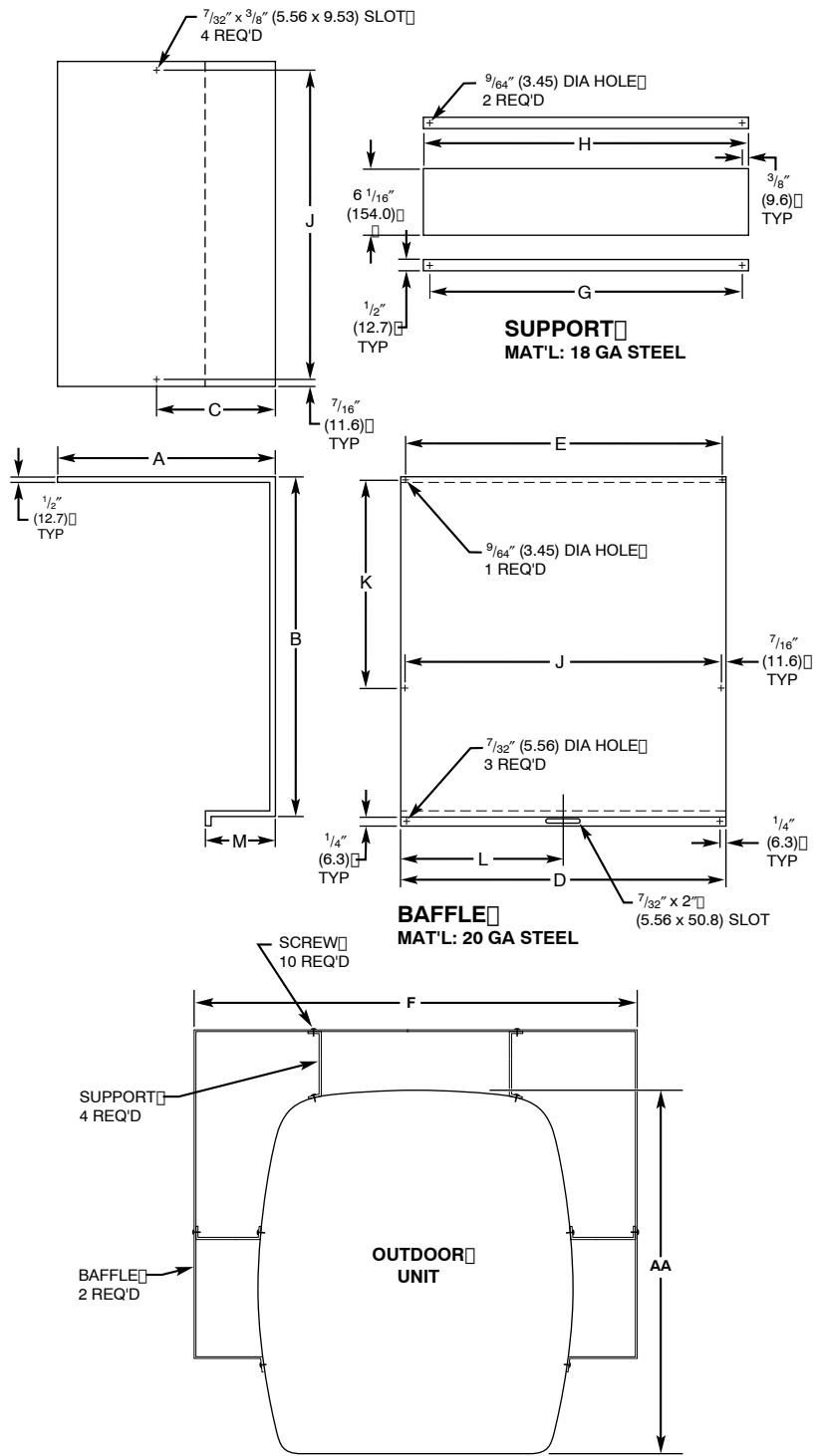


Table 3—Dimensions (In.)

UNIT SIZE	AA	UNIT HEIGHT	A	B	C	D	E	F	G	H	J	K	L
Small	26-3/16	23-13/16	17-1/4	24-5/16	10-1/4	19-3/4	20-1/2	34-1/2	19-5/8	20-3/8	19-5/8	0	0
		27-13/16	17-1/4	24-5/16	10-1/4	23-3/4	24-1/2	34-1/2	23-5/8	24-3/8	23-5/8	0	11-7/8
		33-13/16	17-1/4	24-5/16	10-1/4	29-3/4	30-1/2	34-1/2	29-5/8	30-3/8	29-5/8	0	14-7/8
Medium	33	27-13/16	21	30-5/8	10-1/4	23-3/4	24-1/2	42	23-5/8	24-3/8	23-5/8	17-1/8	11-7/8
		33-13/16	21	30-5/8	10-1/4	29-3/4	30-1/2	42	29-5/8	30-3/8	29-5/8	17-1/8	14-7/8
		39-13/16	21	30-5/8	10-1/4	35-3/4	36-1/2	42	35-5/8	36-3/8	35-5/8	17-1/8	17-7/8
Large	42-1/16	33-13/16	25-5/16	39-3/4	10-1/4	29-3/4	30-1/2	50-9/16	29-5/8	30-3/8	29-5/8	21-11/16	14-7/8
		39-13/16	25-5/16	39-3/4	10-1/4	35-3/4	36-1/2	50-9/16	35-5/8	36-3/8	35-5/8	21-11/16	17-7/8

Fig. 1—Wind Baffle Construction/Tech 2000

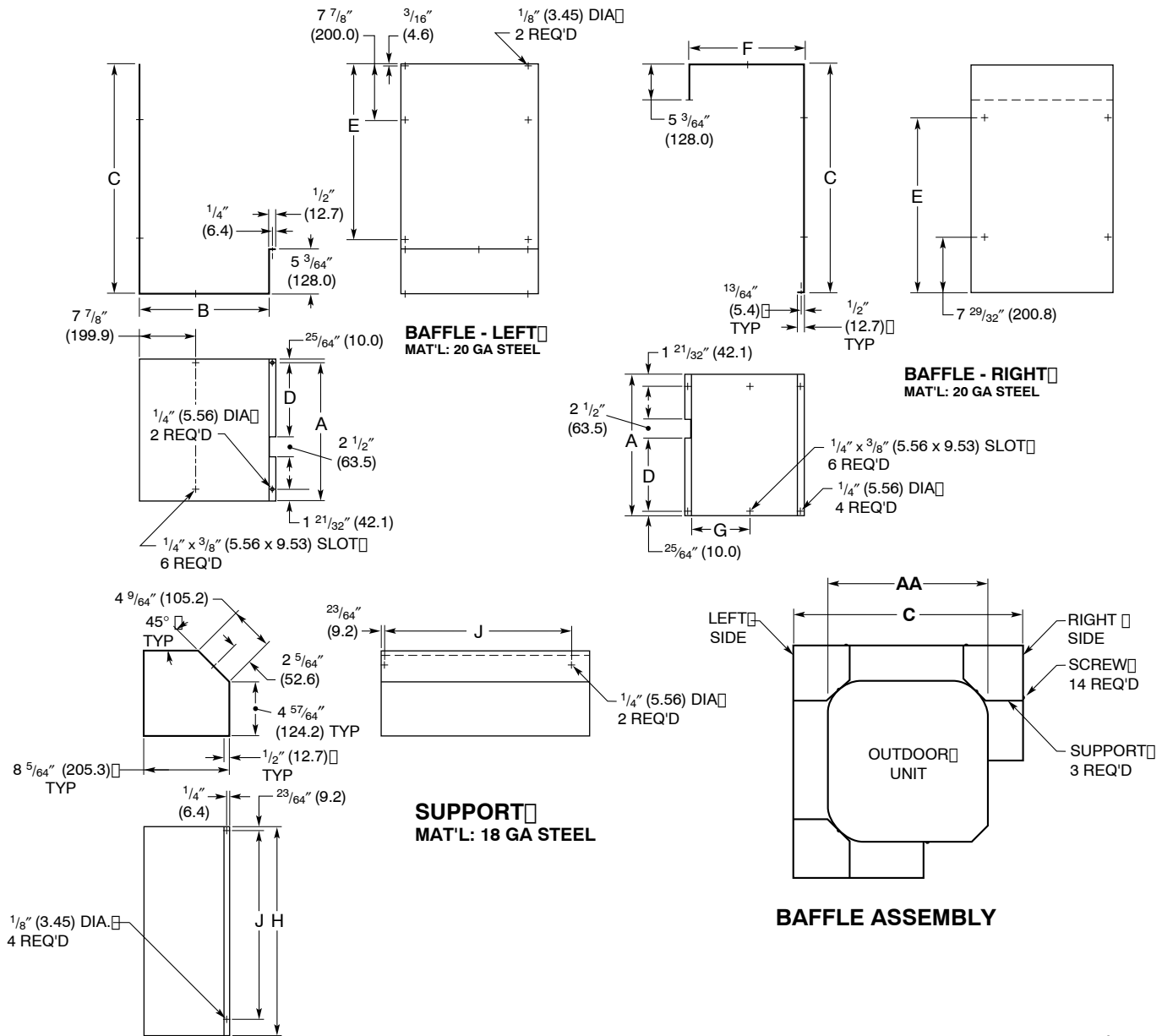


Fig. 2—Wind Baffle/Construction Cube Units

covers opening below the control box. On larger models information plate may not cover entire opening. In this instance, access panel can be removed and placed on its side to cover additional space.

Step 4—Control Box Cover—Cube Products

This panel contains much of the same information as the information plate mentioned previously, but is designed only to cover the control box.

Step 5—Remove Top Cover—Cube Products

1. Turn off all power to outdoor an indoor units.
2. Remove 5 screws holding top cover to coil grille and coil tube sheet.
3. Remove 2 screws holding control box cover.
4. Remove 2 screws holding information plate.
5. Disconnect fan motor wires, cut any wire ties, and move wires out of control box and through tube clamp on back of control box.

6. Lift top cover from unit.
7. Reverse sequence for reassembly.

Step 6—Remove Fan Motor Assembly—Cube Products

1. Perform items 1, 3, 4, and 5 above. (Note item 2 is not required.)
2. Remove 4 screws holding wire basket to top cover.
3. Lift wire basket from unit.
4. Remove nuts holding fan motor to wire basket.
5. Remove motor and fan blade assembly.
6. Pull wires through wire raceway to change motor.
7. Reverse sequence for reassembly.
8. Prior to applying power, check that fan rotates freely.

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Table 4—Wind Baffle for Cube Units (In.)

UNIT SIZE	AA	UNIT HEIGHT	A	B	C	D	E	F	G	H	J
Small	18	21-15/16	19-7/8	13-3/4	28-1/8	10-11/16	20-1/4	11-11/16	3-13/16	19-13/16	17-13/16
		23-15/16	21-7/8	13-3/4	28-1/8	10-11/16	20-1/4	11-11/16	3-13/16	21-13/16	19-13/16
		25-15/16	23-7/8	13-3/4	28-1/8	10-11/16	20-1/4	11-11/16	3-13/16	23-13/16	21-13/16
		27-15/16	25-7/8	13-3/4	28-1/8	10-11/16	20-1/4	11-11/16	3-13/16	25-13/16	23-13/16
		29-15/16	27-7/8	13-3/4	28-1/8	10-11/16	20-1/4	11-11/16	3-13/16	27-13/16	25-13/16
		31-15/16	29-7/8	13-3/4	28-1/8	10-11/16	20-1/4	11-11/16	3-13/16	29-13/16	27-13/16
		33-15/16	31-7/8	13-3/4	28-1/8	10-11/16	20-1/4	11-11/16	3-13/16	31-13/16	29-13/16
Medium	22-1/2	21-15/16	19-7/8	18-5/16	32-5/8	10-11/16	24-3/4	16-3/16	8-1/4	19-13/16	17-13/16
		23-15/16	21-7/8	18-5/16	32-5/8	10-11/16	24-3/4	16-3/16	8-1/4	21-13/16	19-13/16
		25-15/16	23-7/8	18-5/16	32-5/8	10-11/16	24-3/4	16-3/16	8-1/4	23-13/16	21-13/16
		27-15/16	25-7/8	18-5/16	32-5/8	10-11/16	24-3/4	16-3/16	8-1/4	25-13/16	23-13/16
		29-15/16	27-7/8	18-5/16	32-5/8	10-11/16	24-3/4	16-3/16	8-1/4	27-13/16	25-13/16
		31-15/16	29-7/8	18-5/16	32-5/8	10-11/16	24-3/4	16-3/16	8-1/4	29-13/16	27-13/16
		33-15/16	31-7/8	18-5/16	32-5/8	10-11/16	24-3/4	16-3/16	8-1/4	31-13/16	29-13/16
		35-15/16	33-7/8	18-5/16	32-5/8	10-11/16	24-3/4	16-3/16	8-1/4	33-13/16	31-13/16
37-15/16	35-7/8	18-5/16	32-5/8	10-11/16	24-3/4	16-3/16	8-1/4	35-13/16	33-13/16		
Large	30	25-15/16	23-7/8	25-3/4	40-1/8	10-11/16	32-1/4	23-11/16	15-13/16	23-13/16	21-13/16
		27-15/16	25-7/8	25-3/4	40-1/8	10-11/16	32-1/4	23-11/16	15-13/16	25-13/16	23-13/16
		29-15/16	27-7/8	25-3/4	40-1/8	10-11/16	32-1/4	23-11/16	15-13/16	27-13/16	25-13/16
		31-15/16	29-7/8	25-3/4	40-1/8	10-11/16	32-1/4	23-11/16	15-13/16	29-13/16	27-13/16
		33-15/16	31-7/8	25-3/4	40-1/8	10-11/16	32-1/4	23-11/16	15-13/16	31-13/16	29-13/16
		35-15/16	33-7/8	25-3/4	40-1/8	10-11/16	32-1/4	23-11/16	15-13/16	33-13/16	31-13/16
		37-15/16	35-7/8	25-3/4	40-1/8	10-11/16	32-1/4	23-11/16	15-13/16	35-13/16	33-13/16
		39-15/16	37-7/8	25-3/4	40-1/8	10-11/16	32-1/4	23-11/16	15-13/16	37-13/16	35-13/16

Table 5—Refrigerant Connections and Recommended Liquid and Vapor Tube Diameters (Heat Pumps)

UNIT SIZE	CONNECTION DIAMETER (IN.)		TUBE DIAMETER (IN.)		TUBE DIAMETER (ALTERNATE) (IN.)	RST TUBE DIAMETERS NOT PERMITTED (IN.)
	Liquid	Vapor	Liquid	Vapor	Vapor	Vapor
018	3/8	5/8	3/8	5/8	1/2	3/4, 7/8, and 1-1/8
024	3/8	5/8	3/8	5/8	3/4 ACR	3/4
030	3/8	3/4	3/8	3/4	7/8	1-1/8
036	3/8	3/4	3/8	3/4	7/8	1-1/8
042–048	3/8	7/8	3/8	7/8	7/8	3/4 and 1-1/8
060	3/8	7/8	3/8	1-1/8	7/8	3/4

NOTE: 1. Tube diameters are for lengths up to 50ft. For tubing lengths greater than 50 ft, consult the Long-Line section of this manual.
 2. Refrigerant tubes and indoor coils must be evacuated to 500 microns to minimize contamination and moisture in the system.

ELECTRICAL

⚠ WARNING

Exercise extreme caution when working on any electrical components. Shut off all power to system prior to troubleshooting. Some troubleshooting techniques require power to remain on. In these instances, exercise extreme caution to avoid danger of electrical shock. **ONLY TRAINED SERVICE PERSONNEL SHOULD PERFORM ELECTRICAL TROUBLESHOOTING.** Failure to follow this warning can cause a fire, personal injury, or death.

Step 1—Aluminum Wire

⚠ CAUTION

Aluminum wire may be used in the branch circuit (such as the circuit between the main and unit disconnect), but only copper wire may be used between the unit disconnect and the unit.

Whenever aluminum wire is used in branch circuit wiring with this unit, adhere to the following recommendations.

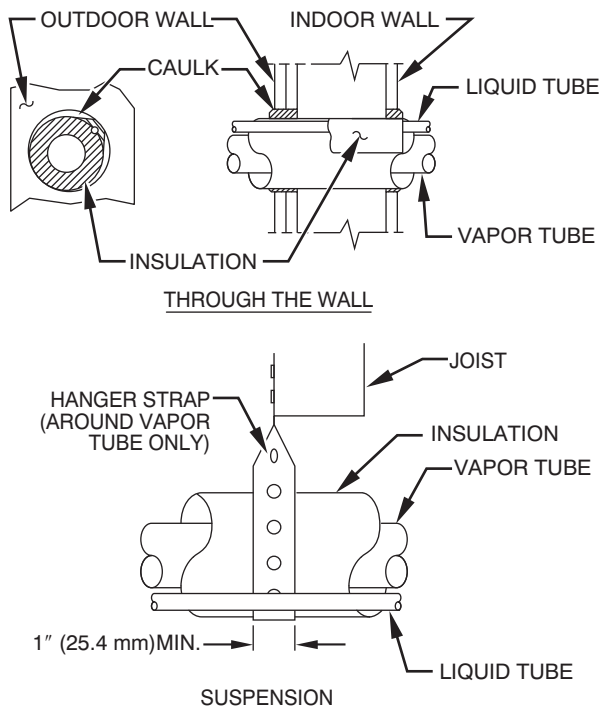
Connections must be made in accordance with the National Electrical Code (NEC), using connectors approved for aluminum wire. The connectors must be UL approved (marked Al/Cu with the UL symbol) for the application and wire size. The wire size selected must have a current capacity not less than that of the copper wire specified, and must not create a voltage drop between service panel and unit in excess of 2

of unit rated voltage. To prepare wire before installing connector, all aluminum wire must be “brush-scratched” and coated with a corrosion inhibitor such as Pentrox A. When it is suspected that connection will be exposed to moisture, it is very important to cover entire connection completely to prevent an electrochemical action that will cause connection to fail very quickly. Do not reduce effective size of wire, such as cutting off strands so that wire will fit a connector. Proper size connectors should be used. Check all factory and field electrical connections for tightness. This should also be done after unit has reached operating temperatures, especially if aluminum conductors are used.

Step 2—Contactor

The contactor provides a means of applying power to unit using low voltage (24v) from transformer in order to power contactor

NOTE: Avoid contact between tubing and structure



A94028

Fig. 3—Tubing Support

coil. (See Fig. 13.) Depending on unit model, you may encounter single- or double-pole contactors. Exercise extreme caution when troubleshooting as 1 side of line may be electrically energized.

The contactor coil is powered by 24vac. If contactor does not operate:

1. With power off, check whether contacts are free to move. Check for severe burning or arcing on contact points.
2. With power off, use ohmmeter to check for continuity of coil. Disconnect leads before checking. A low resistance reading is normal. Do not look for a specific value, as different part numbers will have different resistance values.
3. Reconnect leads and apply low-voltage power to contactor coil. This may be done by leaving high-voltage power to outdoor unit off and turning thermostat to cooling. Check voltage at coil with voltmeter. Reading should be between 20v and 30v. Contactor should pull in if voltage is correct and coil is good. If contactor does not pull in, replace contactor.
4. With high-voltage power off and contacts pulled in, check for continuity across contacts with ohmmeter. A very low or 0 resistance should be read. Higher readings could indicate burned or pitted contacts which may cause future failures.

Step 3—Capacitor

⚠ CAUTION

Capacitors can store electrical energy when power is off. Electrical shock can result if you touch the capacitor terminals and discharge the stored energy. Exercise extreme caution when working near capacitors. With power off, discharge stored energy by shorting across the capacitor terminals with a 15,000-ohm, 2-watt resistor.

NOTE: If bleed resistor is wired across start capacitor, it must be disconnected to avoid erroneous readings when ohmmeter is applied across capacitor. (See Fig. 14.)

⚠ CAUTION

Always check capacitors with power off. Attempting to troubleshoot a capacitor with power on can be dangerous. Defective capacitors may explode when power is applied. Insulating fluid inside is combustible and may ignite, causing burns.

Capacitors are used as a phase-shifting device to aid in starting certain single-phase motors. Check capacitors as follows:

1. With power off, discharge capacitors as outlined above. Disconnect capacitor from circuit. Put ohmmeter on R X 10k scale. Using an analog ohmmeter, check each terminal to ground (use capacitor case). Discard any capacitor which measures 1/2 scale deflection or less. Place ohmmeter leads across capacitor and place on R X 10k scale. Meter should jump to a low resistance value and slowly climb to higher value. Failure of meter to do this indicates an open capacitor. If resistance stays at 0 or a low value, capacitor is internally shorted.
2. Capacitance testers are available which will read value of capacitor. If value is not within ± 10 percent value stated on capacitor, it should be replaced. If capacitor is not open or shorted, the capacitance value is calculated by measuring voltage across capacitor and current it draws.

⚠ WARNING

Exercise extreme caution when taking readings while power is on. Electrical shock can cause personal injury or death.

Use following formula to calculate capacitance:

$$\text{Capacitance (mfd)} = (2650 \times \text{amps}) / \text{volts}$$

3. Remove any capacitor that shows signs of bulging, dents, or leaking. Do not apply power to a defective capacitor as it may explode.

Sometimes under adverse conditions, a standard run capacitor in a system is inadequate to start compressor. In these instances, a start assist device is used to provide an extra starting boost to compressor motor. This device is called a positive temperature coefficient (PTC) or start thermistor. (See Fig. 15.) It is a resistor wired in parallel with the run capacitor. As current flows through the PTC at start-up, it heats up. As PTC heats up, its resistance increases greatly until it effectively lowers the current through itself to an extremely low value. This, in effect, removes the PTC from the circuit.

After system shutdown, resistor cools and resistance value returns to normal until next time system starts. Thermistor device is adequate for most conditions, however, in systems where off cycle is short, device cannot fully cool and becomes less effective as a start device. It is an easy device to troubleshoot. Shut off all power to system.

Check thermistor with ohmmeter as described below. Shut off all power to unit. Remove PTC from unit. Wait at least 10 minutes for PTC to cool to ambient temperature.

Measure resistance of PTC with ohmmeter as shown in Fig. 15.

The cold resistance (RT) of any PTC device should be approximately 100-180 percent of device ohm rating.

$$12.5\text{-ohm PTC} = 12.5\text{-}22.5 \text{ ohm resistance (beige color)}$$

If PTC resistance is appreciably less than rating or more than 200 percent higher than rating, device is defective.

Step 4—Cycle Protector

Solid-state cycle protector protects unit compressor by preventing short cycling. After a system shutdown, cycle protector provides

Table 6—Estimated Percentage of Nominal Cooling Capacity Losses

UNIT NOMINAL SIZE (BTU)	STANDARD VAPOR LINE* (IN.)	LONG-LINE VAPOR LINE† (IN.)	PERCENTAGE OF COOLING CAPACITY LOSS (BTU) VERSUS EQUIVALENT LENGTH‡						
			25 Ft	50 Ft	75 Ft	100 Ft	125 Ft	150 Ft	175 Ft
18,000	5/8	1/2	1	1	2	2	3	4	5
		5/8	0	1	2	2	3	4	5
24,000	5/8	5/8	0	1	2	3	4	6	7
		3/4	0	0	0	1	1	2	2
		7/8**	0	0	0	0	0	1	1
30,000	3/4	5/8**	1	2	3	4	5	6	7
		3/4	0	0	1	1	2	2	2
		7/8	0	0	0	0	1	1	1
36,000	3/4	5/8**	1	3	5	6	8	9	11
		3/4	0	1	1	2	3	3	4
		7/8	0	0	0	0	1	1	2
42,000	7/8	3/4**	0	1	2	2	3	4	5
		7/8	0	0	0	1	1	1	2
		1-1/8**	0	0	0	0	0	0	0
48,000	7/8	3/4**	1	1	2	3	2	4	7
		7/8	0	0	1	1	2	3	3
		1-1/8**	0	0	0	0	0	0	1
60,000	1-1/8	3/4**	2	3	5	7	8	10	11
		7/8	1	2	2	3	4	5	6
		1-1/8	0	0	1	1	1	1	2

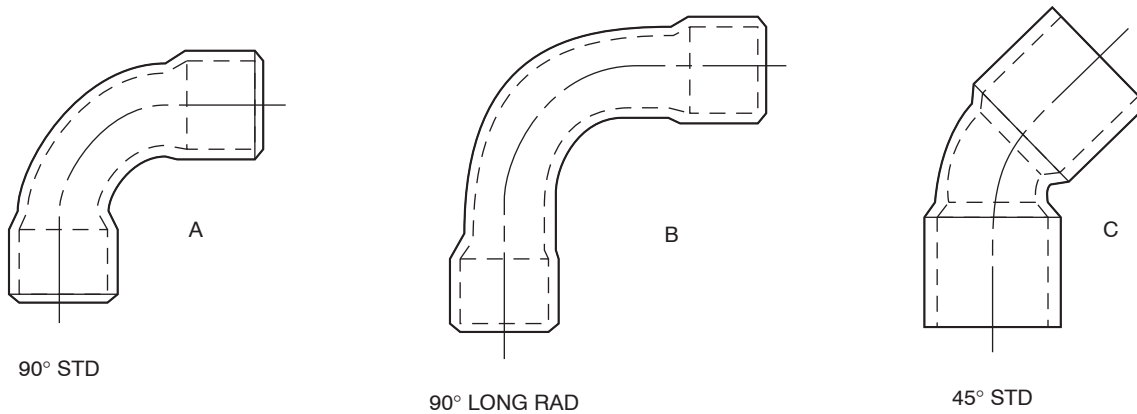


Fig. 4—Tube Bend Losses

Table 7—Fitting Losses in Equivalent Ft

TUBE SIZE OD (IN.)	REFERENCE DIAGRAM IN FIG. 4		
	A	B	C
1/2	1.2	0.8	0.6
5/8	1.6	1.0	0.8
3/4	1.8	1.2	0.9
7/8	2.0	1.4	1.0
1-1/8	2.6	1.7	1.3

for a 5 ± 2-minute delay before compressor restarts. On normal start-up, a 5-minute delay occurs before thermostat closes. After thermostat closes, cycle protector device provides a 3-sec delay. (See Fig. 17, 18, and 19.)

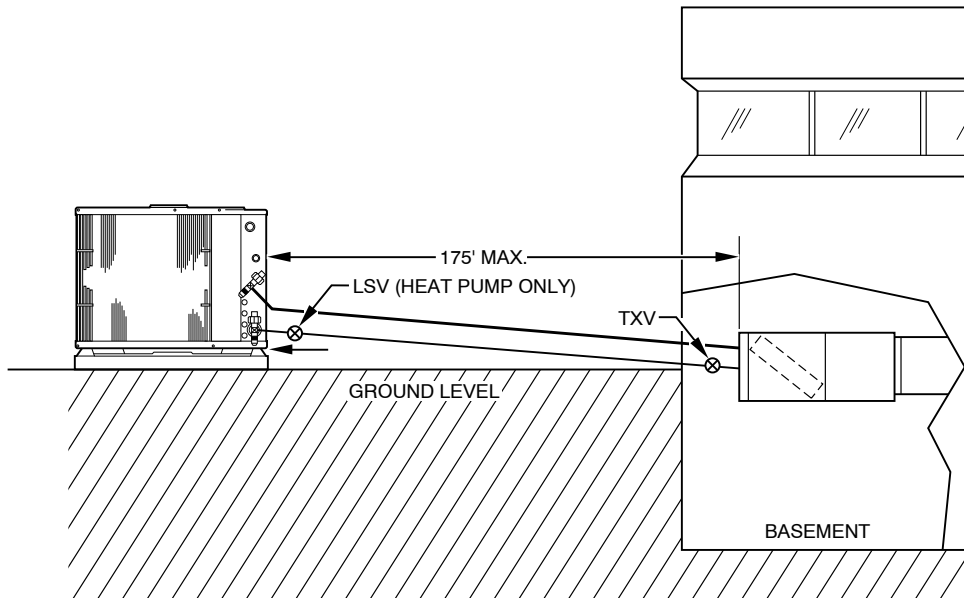
Cycle protector is simple to troubleshoot. Only a voltmeter capable of reading 24v is needed. Device is in control circuit, therefore, troubleshooting is safe with control power (24v) on and high-voltage power off.

With high-voltage power off, attach voltmeter leads across T1 and T3, and set thermostat so that Y terminal is energized. Make sure all protective devices in series with Y terminal are closed.

Voltmeter should read 24v across T1 and T3. With 24v still applied, move voltmeter leads to T2 and T3. After 5 ± 2 minutes, voltmeter should read 24v, indicating control is functioning normally. If no time delay is encountered or device never times out, change control.

Step 5—Crankcase Heater

Crankcase heater is a device for keeping compressor oil warm. By keeping oil warm, refrigerant does not migrate to and condense in compressor shell when the compressor is off. This prevents flooded starts which can damage compressor.



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- A hard shutoff TXV must be installed at indoor unit.
- A crankcase heater must be installed on compressor.
- Vapor line should slope toward indoor unit.
- The above requirements provide refrigerant migration protection during off-cycle due to temperature or slight elevation differences between indoor and outdoor units.
- Maximum equivalent line length is 175 ft between indoor and outdoor units.
- Heat Pump Only Bi-flow liquid-line solenoid must be installed within 2 ft of outdoor unit with arrow pointing toward outdoor unit.

Fig. 5—Application with Air Conditioner or Heat Pump Installed in a Horizontal Configuration

On units that have a single-pole contactor, the crankcase heater is wired in parallel with contactor contacts and in series with compressor. (See Fig. 20.) When contacts open, a circuit is completed from line side of contactor, through crankcase heater, through run windings of compressor, and to other side of line. When contacts are closed, there is no circuit through crankcase heater because both leads are connected to same side of line. This allows heater to **operate** when system is **not** calling for cooling. The heater **does not operate** when system is calling for cooling.

The crankcase heater is powered by high-voltage power of unit. Use extreme caution troubleshooting this device with power on. The easiest method of troubleshooting is to apply voltmeter across crankcase heater leads to see if heater has power. Do not touch heater. Carefully feel area around crankcase heater. If warm, crankcase heater is probably functioning. Do not rely on this method as absolute evidence heater is functioning. If compressor has been running, the area will still be warm.

With power off and heater leads disconnected, check across leads with ohmmeter. Do not look for a specific resistance reading. Check for resistance or an open circuit. Change heater if an open circuit is detected.

Step 6—Time-Delay Relay

The TDR is a solid-state control, recycle delay timer which keeps indoor blower operating for 90 sec after thermostat is satisfied. This delay enables blower to remove residual cooling in coil after compression shutdown, thereby improving efficiency of system. The sequence of operation is that on closure of wall thermostat and at end of a fixed on delay of 1 sec, fan relay is energized. When

thermostat is satisfied, an off delay is initiated. When fixed delay of 90 ± 20 sec is completed, fan relay is de-energized and fan motor stops. If wall thermostat closes during this delay, TDR is reset and fan relay remains energized. TDR is a 24v device that operates within a range of 15v to 30v and draws about 0.5 amps. If the blower runs continuously instead of cycling off when the fan switch is set to AUTO, the TDR is probably defective and must be replaced.

Step 7—Pressure Switches

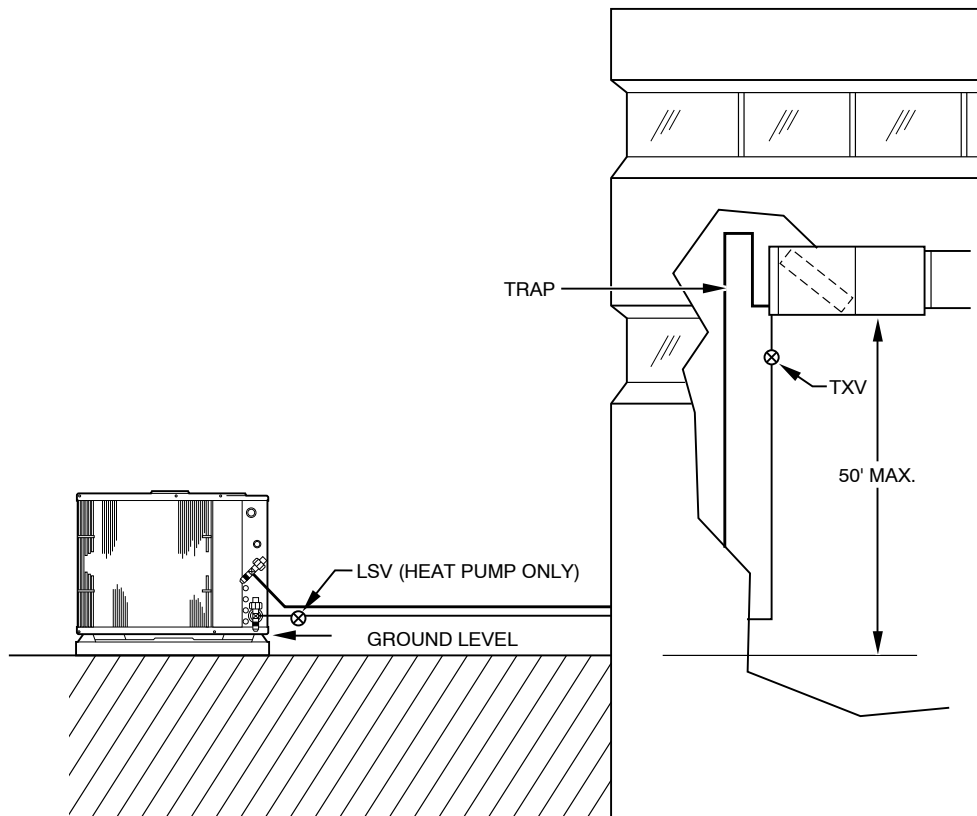
Pressure switches are protective devices wired into control circuit (low voltage). They shut off compressor if abnormally high low pressures are present in the refrigeration circuit. These pressure switches are specifically designed to operate with Puron® systems. R-22 pressure switches must **not** be used as replacements for the Puron® air conditioner. Puron® pressure switches are identified by a pink stripe down each wire.

LOW-PRESSURE SWITCH (A/C ONLY)

The low-pressure switch is located on suction line and protects against low suction pressures caused by such events as loss of charge, low airflow across indoor coil, dirty filters, etc. It opens on a pressure drop at about 50 psig. If system pressure is above this, switch should be closed.

To check switch:

1. Turn off all power to unit.
2. Disconnect leads on switch.
3. Apply ohmmeter leads across switch. You should have continuity on a good switch.



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- A crankcase heater must be installed on compressor.
- An inverted vapor-line trap must be installed at indoor unit. The top peak of trap must be greater than height of indoor coil.
- The above requirements provide protection against condensed refrigerant collecting in the vapor line.
- Maximum elevation between units is 50 ft. Maximum equivalent total line length is 175 ft.
- Heat Pump Only–Bi-flow liquid-line solenoid must be installed within 2 ft of outdoor unit with arrow pointing toward outdoor unit.

Fig. 6—Application with Air Conditioner or Heat Pump Installed with Indoor Unit Above Outdoor Unit

NOTE: Because these switches are attached to refrigeration system under pressure, it is not advisable to remove this device for troubleshooting unless you are reasonably certain that a problem exists. If switch must be removed, remove and recover all system charge so that pressure gages read 0 psi. Never open system without breaking vacuum with dry nitrogen.

⚠ CAUTION

Wear safety glasses and gloves when working with refrigerants.

To replace switch:

1. Apply heat with torch to solder joint and remove switch.

⚠ CAUTION

Wear safety glasses when using torch. Have quenching cloth available. Oil vapor in line may ignite when switch is removed.

2. Braze in 1/4-in. flare fitting and screw on replacement pressure switch.

HIGH-PRESSURE SWITCH

The high-pressure switch is located in liquid line and protects against excessive condenser coil pressure. It opens at 610 psig. High pressure may be caused by a dirty condenser coil, failed fan motor, or condenser air recirculation.

To check switch:

1. Turn off all power to unit.

2. Disconnect leads on switch.
3. Apply ohmmeter leads across switch. You should have continuity on a good switch.

NOTE: Because these switches are attached to refrigeration system under pressure, it is not advisable to remove this device for troubleshooting unless you are reasonably certain that a problem exists. If switch must be removed, remove and recover all system charge so that pressure gages read 0 psi. Never open system without breaking vacuum with dry nitrogen.

⚠ WARNING

Wear safety glasses and gloves when working with refrigerants.

To replace switch:

1. Apply heat with torch to solder joint and remove switch.

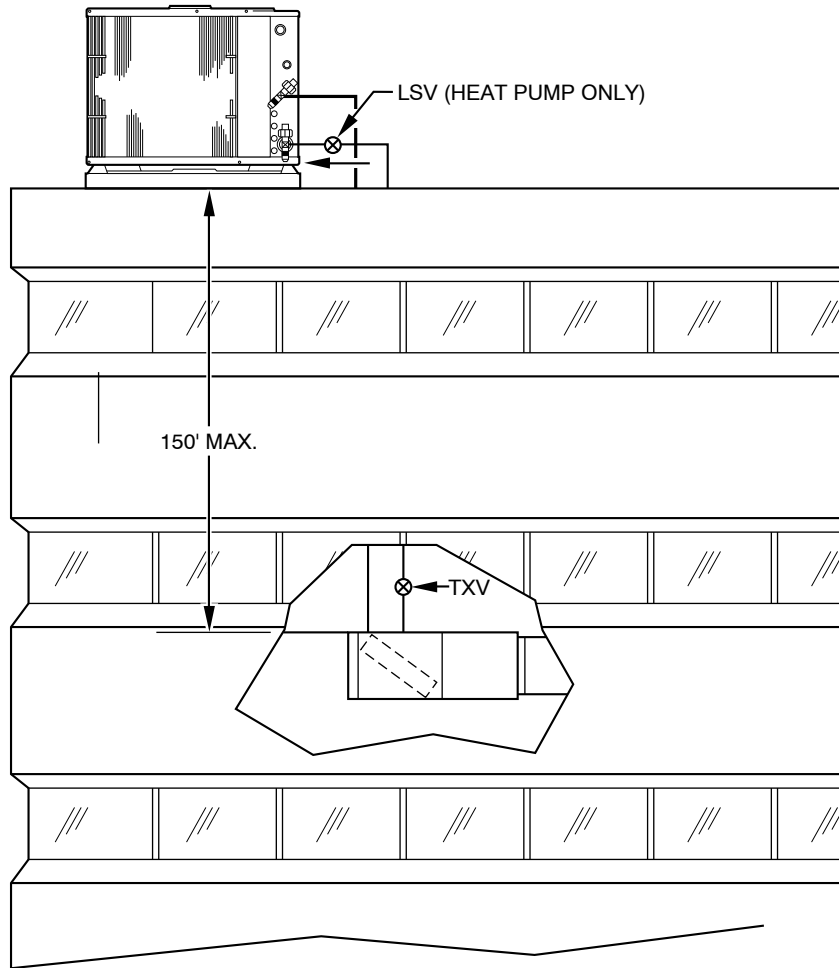
⚠ CAUTION

Wear safety glasses when using torch. have quenching cloth available. Oil vapor in line may ignite when switch is removed.

2. Braze in 1/4-in. flare fitting and replace pressure switch.

LOSS OF CHARGE SWITCH (H/P ONLY)

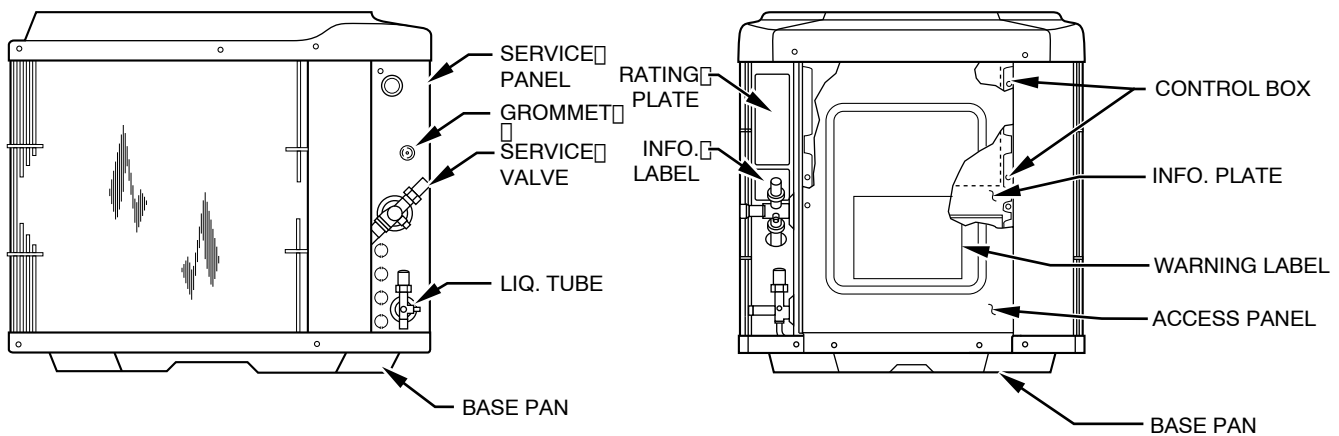
Located on liquid line of heat pump only, the liquid line pressure switch functions similar to conventional low-pressure switch. Because heat pumps experience very low suction pressures during normal system operation, a conventional low-pressure switch



A98328

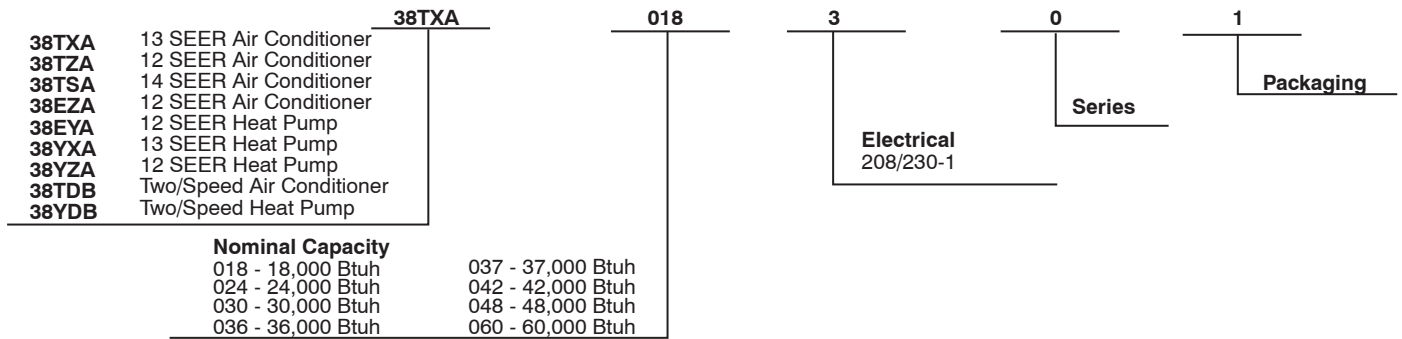
- A crankcase heater must be installed on compressor.
- The above requirements provide protection against refrigerant migration to compressor when outdoor temperature is lower than indoor temperature.
- Maximum elevation between units is 150 ft. Maximum equivalent total line length is 175 ft.
- Heat Pump Only—Bi-flow liquid-line solenoid must be installed within 2 ft of outdoor unit with arrow pointing toward outdoor unit.

Fig. 7—Application with Air Conditioner or Heat Pump with Indoor Unit Below Outdoor Unit



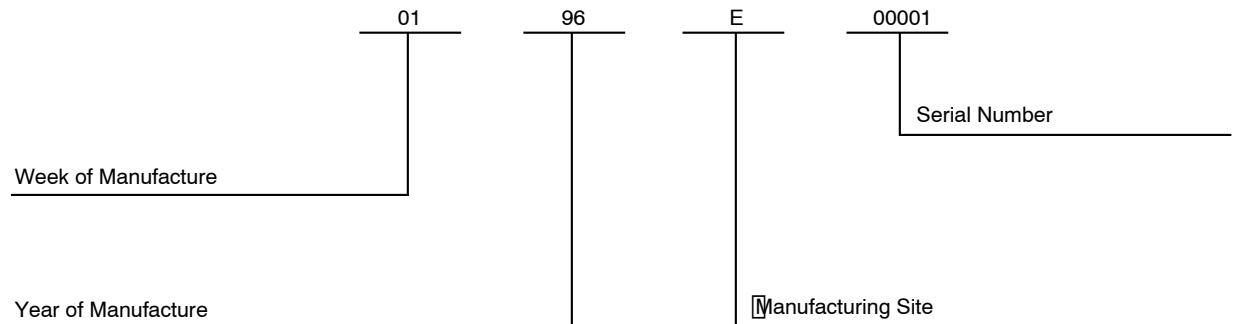
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Fig. 8—Callouts for Puron® Air Conditioner and Heat Pump



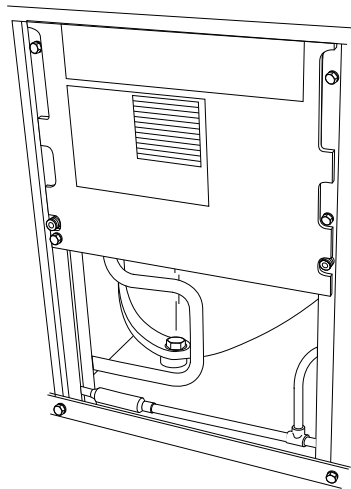
A00427

Fig. 9—Model Number Nomenclature



A95406

Fig. 10—Serial Number Nomenclature



A95506

Fig. 11—Information Plate

cannot be installed on suction line. This switch is installed in liquid line instead and acts as loss-of-charge protector. The liquid-line is the low side of the system in heating mode. It operates identically to low-pressure switch except it opens at 23 psi. Troubleshooting and removing this switch is identical to procedures used on other switches. Observe same safety precautions.

PRESSUREGUARD™ HEATING VAPOR PRESSURE SWITCH (H/P ONLY)

This outdoor unit is equipped with a heating vapor pressure limiting device which cycles the outdoor fan at high ambient heating conditions.

Because Puron® is a high-pressure refrigerant, this switch provides maximum flexibility and minimum cost for the installer/owner by not requiring special thicker wall vapor tubing

and indoor coils, thus allowing limited retrofit. The use of this switch also allows the maximum number of indoor coil choices at minimum cost for the installer/owner, since it can use standard refrigeration tubing.

The effect of outdoor fan cycling on the HSPF (Heating Seasonal Performance Factor) is minimal due to its occurrence at outdoor ambients where building load is very low.

The exact ambient which the outdoor fan cycles depends on the indoor unit size, indoor airflow (including restricted filter and/or coil), refrigerant charge and AccuRater®.

If PressureGuard™ cycles at unsatisfactory low outdoor ambients, check each of the following items.

Ensure ARI approved indoor/outdoor combination is used.

Check for proper airflow per the Product Data Digest. Airflow may be drastically affected by dirty filters, dirty coils, poor duct work, and/or poor duct design.

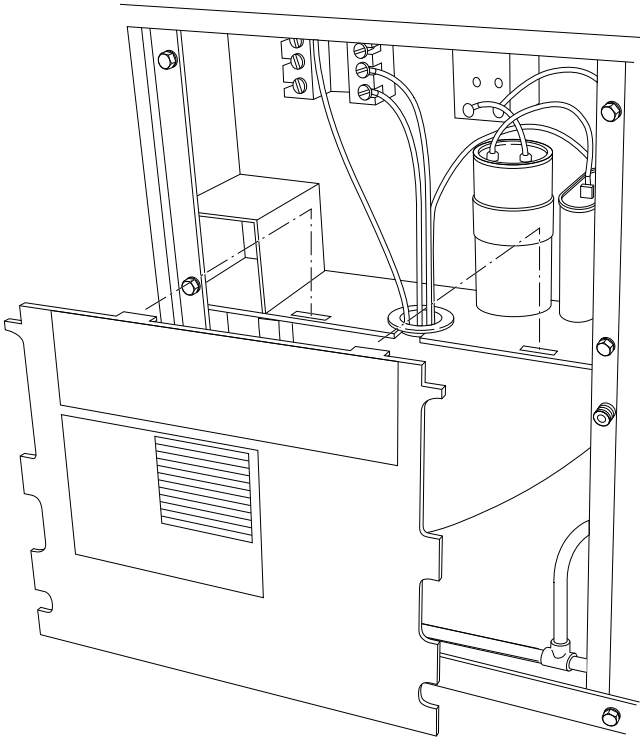
Check refrigerant charge. If in doubt about the proper charge, recharge the unit by the “weigh-in” method if ambient temperature does not allow checking the charge by subcooling method in cooling mode.

Check to ensure the proper outdoor AccuRater® is installed according to the rating plate or the Long Line Guideline.

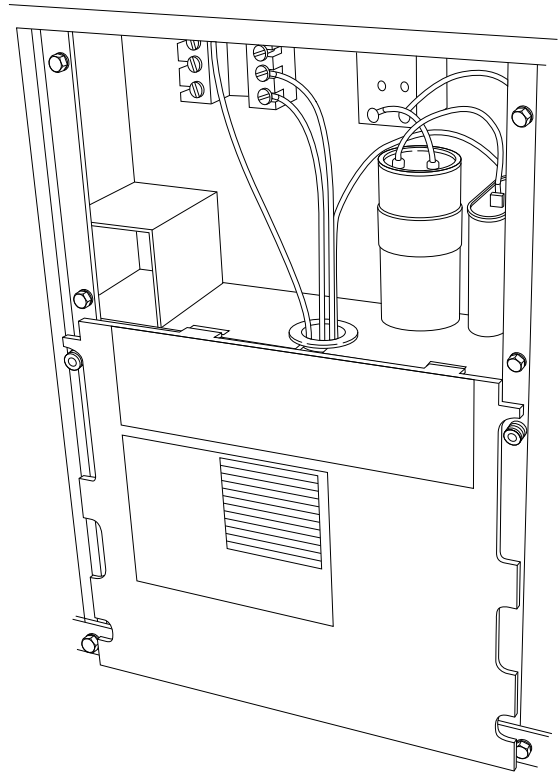
NOTE: Due to the presence of a vapor pressure switch in outdoor unit fan circuit and the possibility of fan cycling, this unit may go into brief defrost at high ambient heating conditions.

Step 8—Discharge Temperature Switch

Heat pump units are equipped with a Discharge Temperature Switch (DTS) located on the compressor discharge line. The DTS is a temperature limiting device which will cycle the compressor contactor. This device protects the compressor in the event of a loss of indoor air, when used in combination with a TXV and an accumulator. The DTS is wired in series with the low and high pressure switches and opens at 275°F and closes at 225°F.

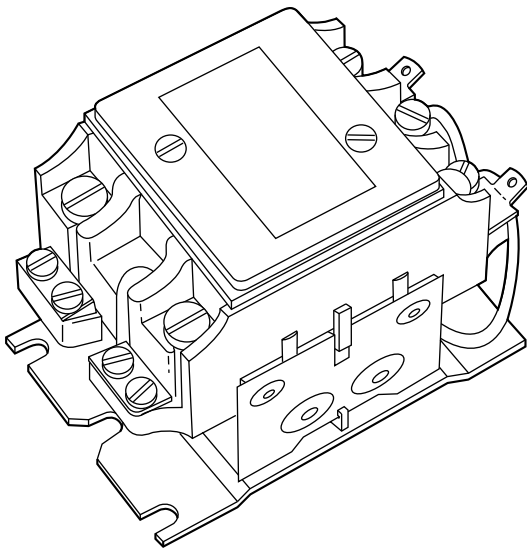


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A95508

Fig. 12—Information Plate Removed/Installed Below Control Box



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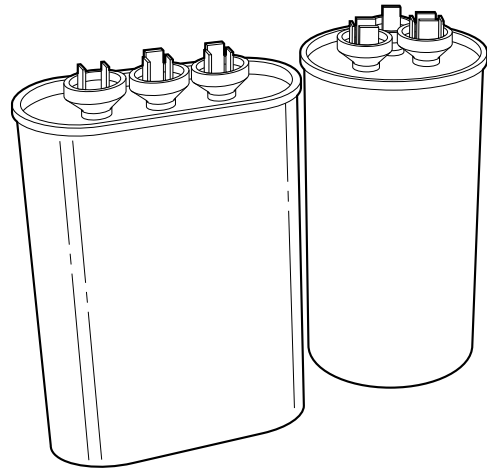
Fig. 13—Contactor

Step 9—Check Defrost Thermostat

There is a liquid header with a brass distributor and feeder tube going into outdoor coil. At the end of 1 of the feeder tubes, there is a 3/8-in. OD stub tube approximately 3 in. long. (See Fig. 21.) The defrost thermostat should be located on stub tube. Note that there is only 1 stub tube used with a liquid header, and on most units it is the bottom circuit.

Step 10—Defrost Thermostats

Defrost thermostat signals heat pump that conditions are right for defrost or that conditions have changed to terminate defrost. It is



A94006

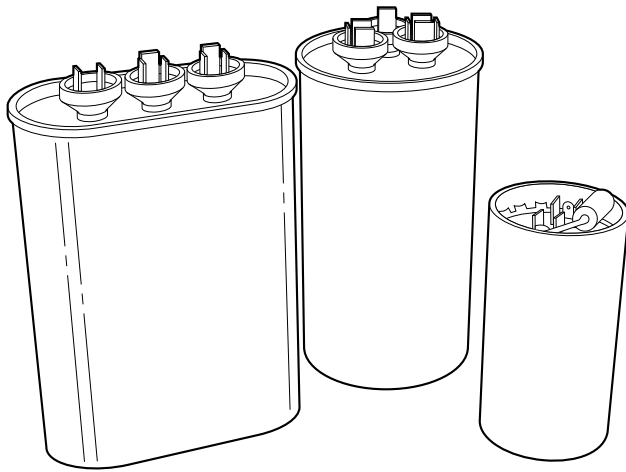
Fig. 14—Capacitors

a thermally actuated switch clamped to outdoor coil to sense its temperature. Normal temperature range is closed at $30^{\circ} \pm 3^{\circ}\text{F}$ and open at $80^{\circ} \pm 5^{\circ}\text{F}$.

NOTE: The defrost thermostat must be located on the liquid side of the outdoor coil on the bottom circuit and as close to the coil as possible.

Step 11—Defrost Control Board

Solid-state defrost boards used on heat pumps replace electromechanical timer and defrost relay found on older defrost systems. The defrost control board can be field set to check need for defrost every 30, 50, or 90 minutes of operating time by connecting the jumper (labeled W1 on the circuit board) to the terminal for the



A91455

Fig. 15—PTC Device

defrost time desired. The board is set at factory for 90 minutes. The defrost period is field selectable, depending upon geographic areas and defrost demands.

Troubleshooting defrost control involves a series of simple steps that indicate whether or not board is defective.

NOTE: This procedure allows the service technician to check control board and defrost thermostat for defects. First, troubleshoot to make sure unit operates properly in heating and cooling modes. This ensures operational problems are not attributed to the defrost control board.

CES0110063—DEFROST CONTROL

All heat pumps in this line use the CES0110063 defrost control. This control board has a connector plug with stripped wire leads. It also contains a feature that allows the heat pump to restart in defrost if the room thermostat is satisfied during defrost. The board also contains a 5-minute cycle protector that prevents the unit from short cycling after it cycles off or after a power interruption. To troubleshoot the board, perform the following items:

1. Turn thermostat to OFF. Shut off all power to outdoor unit.
2. Remove control box cover for access to electrical components and defrost control board.
3. Disconnect defrost thermostat leads from control board, and connect to ohmmeter. Thermostat leads are black, insulated wires connected to DFT and R terminals on control board. Resistance reading may be zero (indicating closed defrost thermostat), or infinity (∞ for open thermostat) depending on outdoor temperature.
4. Jumper between DFT and R terminals on control board as shown in Fig. 20.
5. Disconnect outdoor fan motor lead from OF2. Tape lead to prevent grounding.
6. Turn on power to outdoor unit.
7. Restart unit in heating mode, allowing frost to accumulate on outdoor coil.
8. After a few minutes in heating mode, liquid line temperature at defrost thermostat should drop below closing set point of defrost thermostat of approximately 30°F. Check resistance across defrost thermostat leads using ohmmeter. Resistance of zero indicates defrost thermostat is closed and operating properly.

9. Short between the speed-up terminals using a thermostat screwdriver. This reduces the timing sequence to 1/256 of original time. (See Fig. 22 and Table 8.)

NOTE: Since Fig. 22 shows timing cycle set at 90 minutes, unit initiates defrost within approximately 21 sec. When you hear the reversing valve changing position, remove screwdriver immediately. Otherwise, control will terminate normal 10-minute defrost cycle in approximately 2 sec.

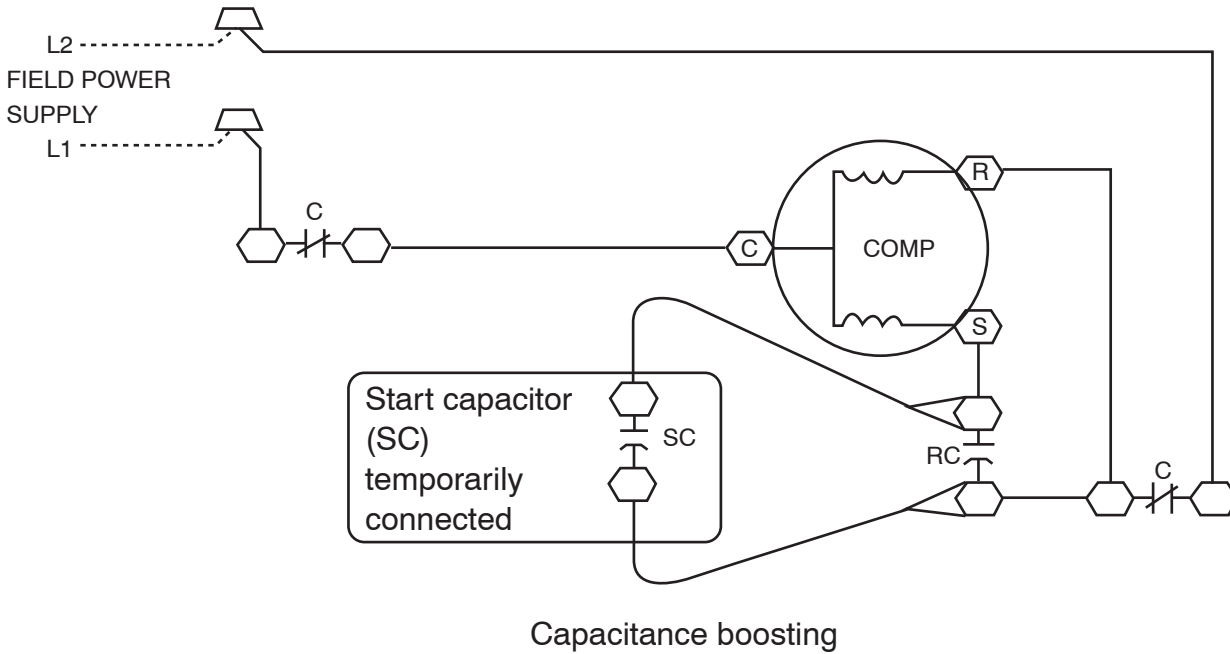
Table 8—Defrost Control Speed-Up Timing Sequence

PARAMETER	MINIMUM (MINUTES)	MAXIMUM (MINUTES)	SPEED-UP (NOMINAL)
30-minute cycle	27	33	7 sec
50-minute cycle	45	55	12 sec
90-minute cycle	81	99	21 sec
10-minute cycle	9	11	2 sec
5 minutes	4.5	5.5	1 sec

⚠ CAUTION

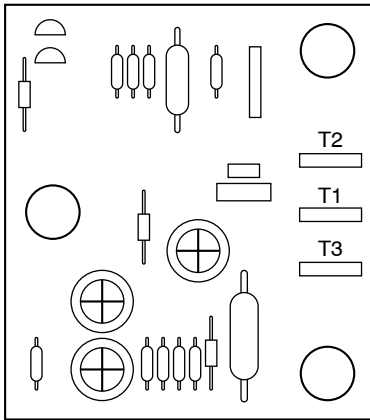
Exercise extreme caution when shorting speed-up pins. If pins are accidentally shorted to other terminals, damage to the control board will occur.

10. Unit is now operating in defrost mode. Check between C and W2 using voltmeter as shown in Fig. 23. Reading on voltmeter should indicate 24v. This step ensures defrost relay contacts have closed, energizing supplemental heat (W2) and reversing valve solenoid (O).
 11. Unit should remain in defrost no longer than 10 minutes. Actual time in defrost depends on how quickly speed-up jumper is removed. If it takes 2 sec to remove speed-up jumper after unit has switched to defrost, the unit will switch back to heat mode.
 12. After a few minutes, in defrost (cooling) operation, liquid line should be warm enough to have caused defrost thermostat contacts to open. Check resistance across defrost thermostat. Ohmmeter should read infinite resistance, indicating defrost thermostat has opened at approximately 80°F.
 13. Shut off unit power and reconnect fan lead.
 14. Remove jumper between DFT and R terminals. Reconnect defrost thermostat leads. Failure to remove jumper causes unit to switch to defrost every 30, 50, or 90 minutes and remain in defrost for full 10 minutes.
 15. Replace control box cover. Restore power to unit.
- If defrost thermostat does not check out following above items or incorrect calibration is suspected, check for defective thermostat as follows
1. Follow items 1-5 above.
 2. Route sensor or probe underneath coil (or other convenient location) using thermocouple temperature measuring device. Attach to liquid line near defrost thermostat. Insulate for more accurate reading.
 3. Turn on power to outdoor unit.
 4. Restart unit in heating.
 5. Within a few minutes, liquid line temperature drops within a range causing defrost thermostat contacts to close. Temperature range is from 33°F to 27°F. Notice temperature at which ohmmeter reading goes from ∞ to zero ohms. Thermostat contacts close at this point.



A00195

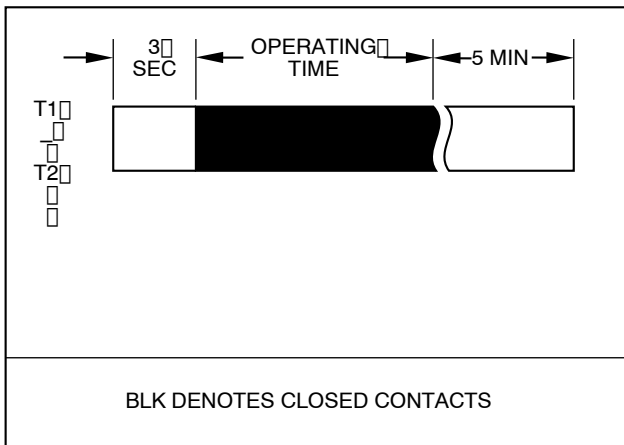
Fig. 16—Capacitance Boosting



HN67ZA008

A94005

Fig. 17—Cycle Protector Device



A94009

Fig. 18—Cycle Protector Sequence

6. Short between the speed-up terminals using a small slotted screwdriver.

7. Unit changes over to defrost within 21 sec (depending on timing cycle setting). Liquid line temperature rises to range where defrost thermostat contacts open. Temperature range is from 75°F to 85°F. Resistance goes from zero to ∞ when contacts are open.
8. If either opening or closing temperature does not fall within above ranges or thermostat sticks in 1 position, replace thermostat to ensure proper defrost operation.

CES0130076—DEFROST CONTROL

This defrost control is the same size as the CES0130063 control, but is not backwards-compatible. To upgrade to the new control, you must have replacement-defrost thermostat and harness kit. See your replacement-component representative for kit part number.

Defrost Settings

The defrost control is a time/temperature control which includes a field-selectable time period (DIP switch 1 and 2 on board, see Table 8) between defrost cycles of 30, 60, 90, and 120 minutes (factory-set at 90 minutes).

Table 9—Defrost Timer Settings

SW1	SW2	DEFROST TIMES IN MINUTES
On	Off	30
Off	On	60
Off	Off	90
On	On	120

To initiate a forced defrost, two options are available, depending on the status of the defrost thermostat.

If defrost thermostat is closed, speedup pins (J1) must be shorted by placing a flathead screwdriver in between for 5 seconds and releasing, to observe a complete defrost cycle. When the Quiet Shift switch is selected, compressor will be turned off for two, 30-sec intervals during this complete defrost cycle. When Quiet Shift switch is in factory-default OFF position, a normal and complete defrost cycle will be observed.

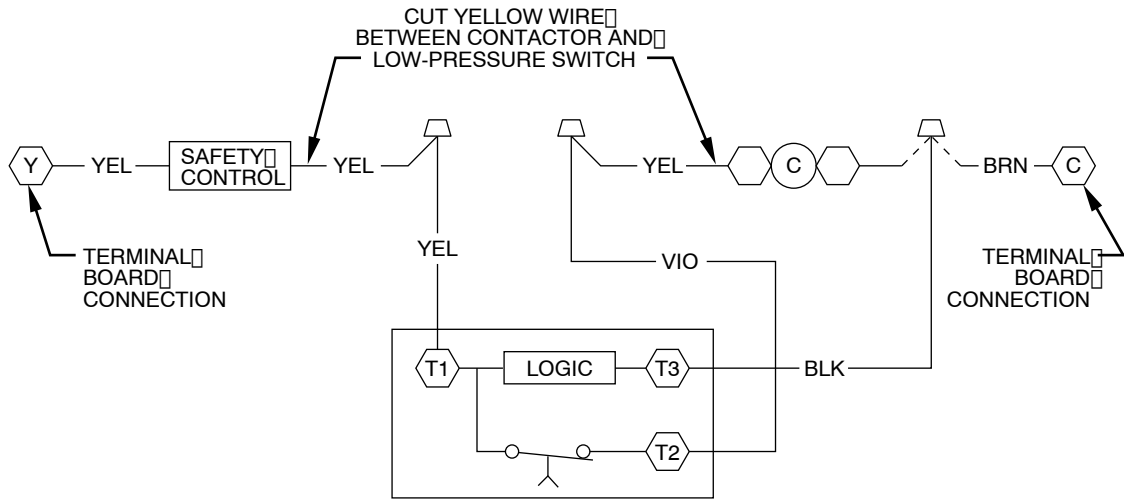


Fig. 19—Cycle Protector Wiring

A88415

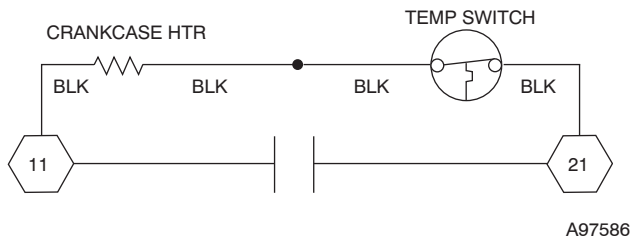


Fig. 20—Wiring for Single-Pole Contactor

A97586

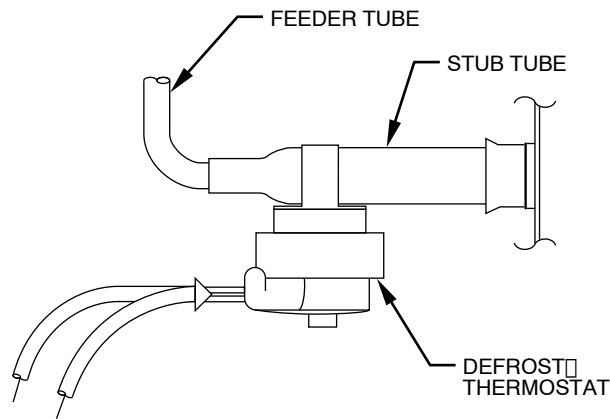


Fig. 21—Defrost Thermostat Location

A97517

If defrost thermostat is in open position and speedup pins are shorted (with a flathead screwdriver) for 5 seconds and released, a short defrost cycle will be observed (actual length is dependent upon the selected Quiet Shift position). When Quiet Shift switch is in ON position, the length of defrost is 1 minute (30 sec compressor-off period followed by 30 sec of defrost with compressor operation). On return to heat operation, compressor will again turn off for an additional 30 sec and the fan for 40 sec. When Quiet Shift is in OFF position, only a brief 30-sec cycle will be observed.

If it is desirable to observe a complete defrost in warmer weather, the thermostat must be closed as follows:

1. Turn off power to outdoor unit.
2. Disconnect outdoor fan-motor lead from OF2 on control board. (See Fig. 23.) Tape to prevent grounding.

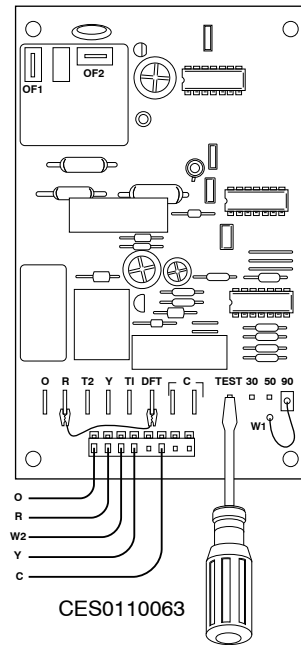


Fig. 22—CES0110063 Defrost Control

A97642

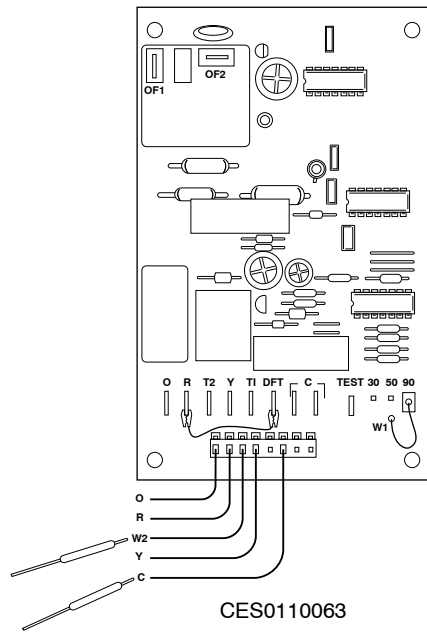
3. Restart unit in heating mode, allowing frost to accumulate on outdoor coil.
4. After a few minutes in heating mode, liquid-line temperature should drop below closing point of defrost thermostat (approximately 30°F.)

NOTE: Unit will remain in defrost until defrost thermostat reopens at approximately 80°F coil temperature at liquid line or remainder of defrost cycle time.

5. Turn off power to outdoor unit and reconnect fan-motor lead to OF2 on control board after above forced-defrost cycle.

Compressor Shut Down

This control has the option of shutting down the compressor for 30 seconds while going into and out of defrost modes. This is accomplished by turning DIP switch 3 to the ON position. See Fig. 24 for switch position. Factory default is in the OFF position.



A97641

Fig. 23—Checking Between C and W2

Five-Minute Time Delay

This control has a 5-minute time delay on startup. The speedup terminals can be used to bypass this delay. Momentary shorting across the speedup terminals for more than 5 seconds, or defrost mode will be initiated.

Troubleshooting

Troubleshooting this control is done in the same manner as the CES0130063 with the exceptions listed above.

Step 12—Fan Motor

Fan motor rotates fan blade that draws air through outdoor coil to perform heat exchange. Motors are totally enclosed to increase reliability. This also eliminates need for rain shield. For the correct position of fan blade assembly, the fan hub should be flush with the motor shaft. Replacement motors and blades may vary slightly.

⚠ WARNING

Turn off all power before servicing or replacing fan motor. Be sure unit main power switch is turned off. Failure to do so may result in electric shock, death, or injury from rotating fan blade.

The bearings are permanently lubricated, therefore, no oil ports are provided.

For suspected electrical failures, check for loose or faulty electrical connections, or defective fan motor capacitor. Fan motor is equipped with thermal overload device in motor windings which may open under adverse operating conditions. Allow time for motor to cool so device can reset. Further checking of motor can be done with an ohmmeter. Set scale on R X 1 position, and check for continuity between 3 leads. Replace motors that show an open circuit in any of the windings. Place 1 lead of ohmmeter on each motor lead. At same time, place other ohmmeter lead on motor case (ground). Replace any motor that shows resistance to ground, arcing, burning, or overheating.

Step 13—Compressor Plug

The compressor electrical plug provides a quick-tight connection to compressor terminals. The plug completely covers compressor terminals and mating female terminals are completely encapsu-

lated in plug. Therefore, terminals are isolated from any moisture so corrosion and resultant pitted or discolored terminals are reduced. The plug is oriented to relief slot in terminal box so cover cannot be secured if wires are not positioned in slot, assuring correct electrical connection at the compressor. The plug can be removed by simultaneously pulling while “rocking” plug. However, these plugs can be used on only specific compressor. The configuration around the fuse terminals is outline of the terminal covers. The slot through which wires of plug are routed is oriented on the bottom and slightly to the left. The correct plug can be connected easily to compressor terminals and plug wires routed easily through slot terminal cover.

Step 14—Low-Voltage Terminals

The low-voltage terminal designations, and their description and function, are used on all split-system condensers.

W—Energizes first-stage supplemental heat through defrost relay (wht).

L—Energizes light on thermostat with service alarm.

W3—Energizes second- or third-stage supplemental heat.

R—Energizes 24-v power from transformer (red).

Y—Energizes contactor for first-stage cooling or first-stage heating for heat pumps (yel).

O—Energizes reversing valve on heat pumps (orn).

C—Common side of transformer (blk).

COPELAND SCROLL COMPRESSOR (W/PURON®)

The compressor used in this product is specifically designed to operate with Puron® refrigerant and cannot be interchanged.

The compressor is an electrical (as well as mechanical) device. Exercise extreme caution when working near compressors. Power should be shut off, if possible, for most troubleshooting techniques. Refrigerants present additional safety hazards.

⚠ WARNING

Wear safety glasses and gloves when handling refrigerants. Failure to follow this warning can cause a fire, personal injury, or death.

The scroll compressor pumps refrigerant through the system by the interaction of a stationary and an orbiting scroll. (See Fig. 25.) The scroll compressor has no dynamic suction or discharge valves, and it is more tolerant of stresses caused by debris, liquid slugging, and flooded starts. The compressor is equipped with an anti-rotational device and an internal pressure relief port. The anti-rotational device prevents the scroll from turning backwards and replaces the need for a cycle protector. The pressure relief port is a safety device, designed to protect against extreme high pressure. The relief port has an operating range between 550 and 625 psi differential pressure.

The Copeland scroll compressor uses 3MA® POE (32 cSt) oil. This is the only oil allowed for oil recharge. (See Table 10.)

Step 1—Compressor Failures

Compressor failures are classified in 2 broad failure categories; mechanical and electrical. Both types are discussed below.

Step 2—Mechanical Failures

A compressor is a mechanical pump driven by an electric motor contained in a welded or hermetic shell. In a mechanical failure, motor or electrical circuit appears normal, but compressor does not function normally.

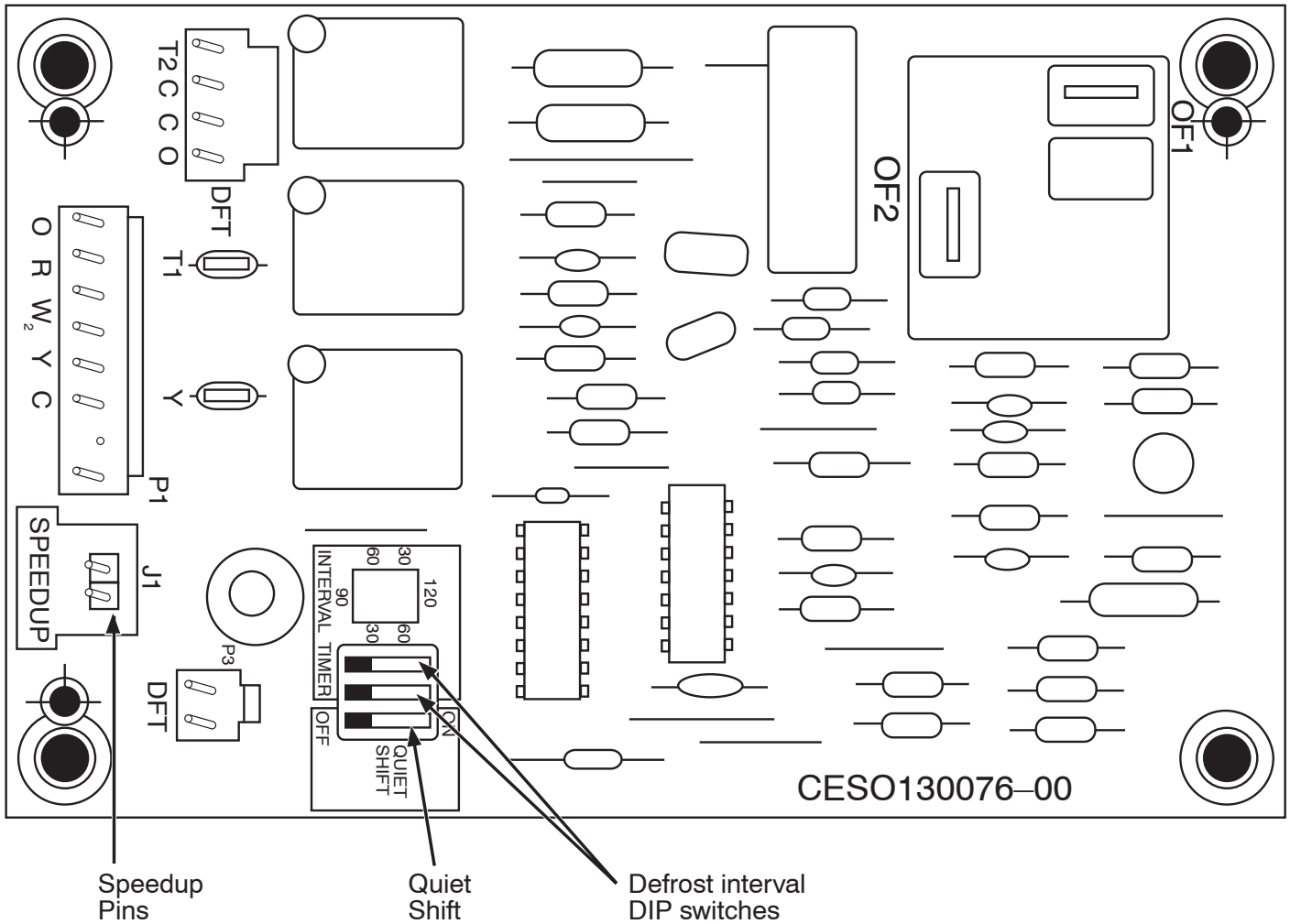


Fig. 24—Defrost Control

A99442

Table 10—Oil Charging

COMPRESSOR MODEL	RECHARGE (FL OZ)	OIL TYPE
COPELAND		
ZP16-26	38	3MA POE (32 cSt)
ZP32-41	42	3MA POE (32 cSt)
ZP54	53	3MA POE (32 cSt)
BRISTOL		
T89B19-38	37	Mobil MCP2134
T89A51	62	Mobil MCP2134
H29B16-30	37	3MA POE (32 cSt)

⚠ WARNING
Do not supply power to unit with compressor terminal box cover removed. Failure to follow this warning can cause a fire, personal injury, or death.

⚠ WARNING
Exercise extreme caution when reading compressor currents when high-voltage power is on. Correct any of the problems described below before installing and running a replacement compressor. Wear safety glasses and gloves when handling refrigerants. Failure to follow this warning can cause a fire, personal injury, or death.

Locked Rotor
In this type of failure, compressor motor and all starting components are normal. When compressor attempts to start, it draws locked rotor current and cycles off on internal protection. Locked rotor current is measured by applying a clamp-on ammeter around common (blk) lead of compressor. Current drawn when it attempts to start is then measured. Locked rotor amp (LRA) value is stamped on compressor nameplate.

If compressor draws locked rotor amps and all other external sources of problems have been eliminated, compressor must be replaced. Because compressor is a sealed unit, it is impossible to determine exact mechanical failure. However, complete system should be checked for abnormalities such as incorrect refrigerant charge, restrictions, insufficient airflow across indoor or outdoor coil, etc., which could be contributing to the failure.

Runs, Does Not Pump
In this type of failure, compressor motor runs and turns compressor, but compressor does not pump refrigerant. A clamp-on ammeter on common leg shows a very low current draw, much

Table 11—PressureGuard™ Heating Vapor Pressure Switch

STANDARD VAPOR LINE SIZE (IN.)	PART NUMBER*	CUT IN (PSI)	CUT OUT (PSI)
1/2	HK02ZB325	325	400
5/8	HK02ZB325	325	400
3/4	HK02ZB309	309	384
7/8	HK02ZB325	325	400
1 1/8	HK02ZB300	300	374

*Use only factory approved Part Numbers

lower than rated load amp (RLA) value stamped on compressor nameplate. Because no refrigerant is being pumped, there is no return gas to cool compressor motor. It eventually overheats and shuts off on its internal protection.

Noisy Compressor

Noise may be caused by a variety of internal or external problems such as loosened hardware. System problems such as an over-charged compressor (especially at start-up) may also cause excessive noise.

Electrical Failures

The compressor mechanical pump is driven by an electric motor within its hermetic shell. In electrical failures, compressor does not run although external electrical and mechanical systems appear normal. Compressor must be checked electrically for abnormalities.

Before troubleshooting compressor motor, review this description of compressor motor terminal identification.

Single-Phase Motors

To identify terminals C, S, and R:

1. Turn off all unit power.
2. Discharge run and start capacitors to prevent shock.
3. Remove all wires from motor terminals.
4. Read resistance between all pairs of terminals using an ohmmeter on 0-10 ohm scale.
5. Determine 2 terminals that provide greatest resistance reading.

Through elimination, remaining terminal must be common (C). Greatest resistance between common (C) and another terminal indicates start winding because it has more turns. This terminals is start (S). Remaining terminal will be run winding (R). (See Fig. 25.)

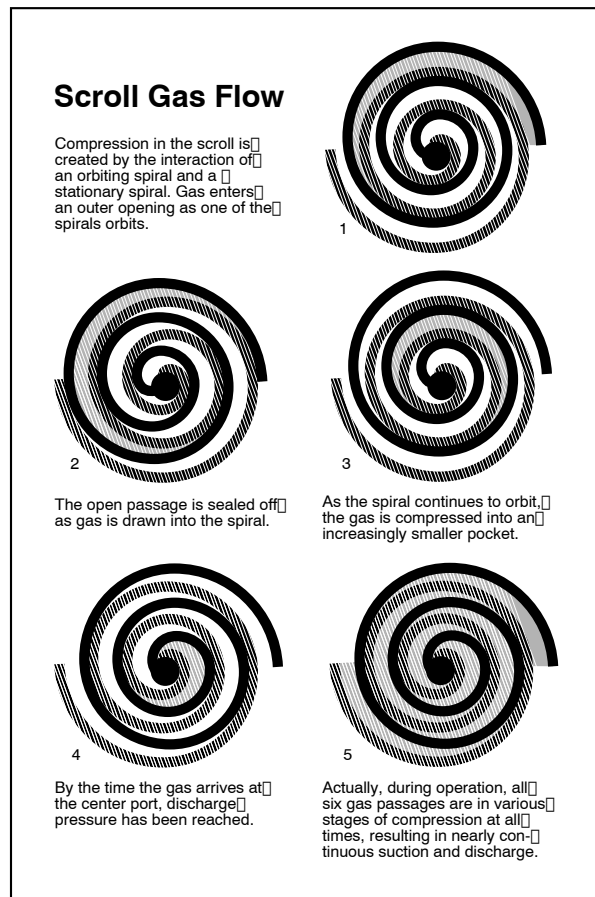
NOTE: If compressor is hot, allow time to cool and internal line break to reset. There is an internal line break protector which must be closed.

NOTE: Ohm readings in Fig. 26 are examples, not actual measurements.

All compressors are equipped with internal motor protection. If motor becomes hot for any reason, protector opens. Compressor should always be allowed to cool and protector to close before troubleshooting. Always turn off all power to unit and disconnect leads at compressor terminals before taking readings.

Most common motor failures are due to either an open, grounded, or short circuit. When a compressor fails to start or run, 3 tests can help determine the problem. First, all possible external causes should be eliminated, such as overloads, improper voltage, pressure equalization, defective capacitor(s), relays, wiring, etc. Compressor has internal line break overload, so be certain it is closed.

Open Circuit



A90198

Fig. 25—Scroll Compressor Refrigerant Flow

To determine if any winding has a break in the internal wires and current is unable to pass through, follow these steps:

1. Be sure all power is off.
2. Discharge all capacitors.
3. Remove wires from terminals C, S, and R.
4. Check resistance from C-R, C-S, and R-S using an ohmmeter on 0-1000 ohm scale.

Because winding resistances are usually less than 10 ohms, each reading appears to be approximately 0 ohm. If resistance remains at 1000 ohms, an open or break exists and compressor should be replaced.

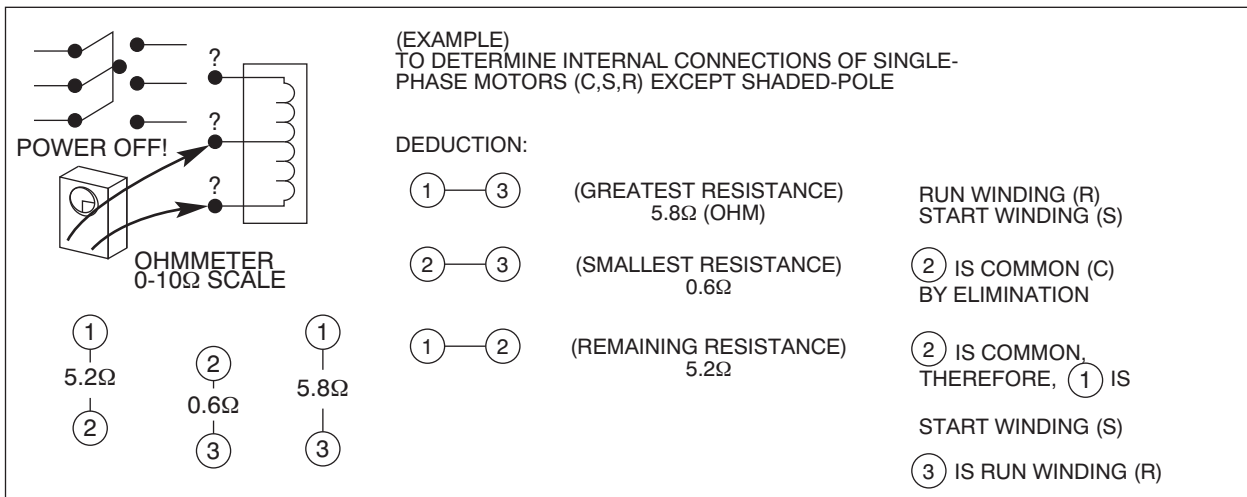
CAUTION

Be sure internal line break overload is not temporarily open.

Ground Circuit

To determine if a wire has broken or come in direct contact with shell, causing a direct short to ground, follow these steps:

1. Allow crankcase heaters to remain on for several hr before checking motor to ensure windings are not saturated with refrigerant.
2. Using an ohmmeter on R X 10,000 ohm scale or megohmmeter (follow manufacturer's instructions).
3. Be sure all power is off.
4. Discharge all capacitors.
5. Remove wires from terminals C, S, and R.



A88344

Fig. 26—Identifying Internal Connections

- Place 1 meter probe on ground or on compressor shell. Make a good metal-to-metal contact. Place other probe on terminals C, S, and R in sequence.
- Note meter scale.
- If reading of 0 or low resistance is obtained, motor is grounded. Replace compressor.

Compressor resistance to ground should not be less than 1000 ohms per volt of operating voltage.

Example:

230 volts X 1000 ohms/volt = 230,000 ohms minimum.

Short Circuit

To determine if any wires within windings have broken through their insulation and made contact with other wires, thereby shorting all or part of the winding(s), be sure the following conditions are met.

- Correct motor winding resistances must be known before testing, either from previous readings or from manufacturer's specifications.
- Temperature of windings must be as specified, usually about 70°F.
- Resistance measuring instrument must have an accuracy within $\pm 5-10$ percent. This requires an accurate ohmmeter such as a Wheatstone bridge or null balance-type instrument.
- Motor must be dry or free from direct contact with liquid refrigerant.

Make This Critical Test

(Not advisable unless above conditions are met)

- Be sure all power is off.
- Discharge all capacitors.
- Remove wires from terminals C, S, and R.
- Place instrument probes together and determine probe and lead wire resistance.
- Check resistance readings from C-R, C-S, and R-S.
- Subtract instrument probe and lead resistance from each reading.

If any reading is within ± 20 percent of known resistance, motor is probably normal. Usually a considerable difference in reading is noted if a turn-to-turn short is present.

REFRIGERATION SYSTEM

Step 1—Refrigerant

CAUTION

This system uses Puron® refrigerant which has higher pressures than R-22 and other refrigerants. No other refrigerant may be used in this system. Gage set, hoses, and recovery system must be designed to handle Puron®. If you are unsure consult the equipment manufacturer.

In an air conditioning and heat pump system, refrigerant transfers heat from one place to another. The condenser is the outdoor coil in the cooling mode and the evaporator is the indoor coil. The condenser is the indoor coil in the heating mode and the evaporator is the outdoor coil. Compressed hot gas leaves the compressor and enters the condensing coil. As gas passes through the condenser coil, it rejects heat and condenses into liquid. The liquid leaves condensing unit through liquid line and enters metering device at evaporator coil. As it passes through metering device, it becomes a gas-liquid mixture. As it passes through indoor coil, it absorbs heat and the refrigerant moves to the compressor and is again compressed to hot gas, and cycle repeats.

Step 2—Compressor Oil

CAUTION

The compressor in a Puron system uses a polyol ester (POE) oil. This oil is extremely hygroscopic, meaning it absorbs water readily. POE oils can absorb 15 times as much water as other oils designed for HCFC and CFC refrigerants. Take all necessary precautions to avoid exposure of the oil to the atmosphere. (See Table 10.)

Step 3—Servicing Systems on Roofs With Synthetic Materials

POE (polyol ester) compressor lubricants are known to cause long term damage to some synthetic roofing materials. Exposure, even if immediately cleaned up, may cause embrittlement (leading to cracking) to occur in one year or more. When performing any service which may risk exposure of compressor oil to the roof, take appropriate precautions to protect roofing. Procedures which risk oil leakage include but are not limited to compressor replacement,

repairing refrigerants leaks, replacing refrigerant components such as filter drier, pressure switch, metering device, coil, accumulator, or reversing valve.

SYNTHETIC ROOF PRECAUTIONARY PROCEDURE

1. Cover extended roof working area with an impermeable polyethelene (plastic) drop cloth or tarp. Cover an approximate 10 x 10 ft area.
2. Cover area in front of the unit service panel with a terry cloth shop towel to absorb lubricant spills and prevent run-offs, and protect drop cloth from tears caused by tools or components.
3. Place terry cloth shop towel inside unit immediately under component(s) to be serviced and prevent lubricant run-offs through the louvered openings in the base pan.
4. Perform required service.
5. Remove and dispose of any oil contaminated material per local codes.

Step 4—Brazeing

Definition: The joining and sealing of metals using a nonferrous metal having a melting point over 800°F.

Flux: A cleaning solution applied to tubing or wire before it is brazed. Flux improves the strength of the brazed connection.

When brazing is required in the refrigeration system, certain basics should be remembered. The following are a few of the basic rules.

1. Clean joints make the best joints. To clean:
 - a. Remove all oxidation from surfaces to a shiny finish before brazing.
 - b. Remove all flux residue with brush and water while material is still hot.
2. Silver brazing alloy is used on copper-to-brass, copper-to-steel, or copper-to-copper. Flux is required when using silver brazing alloy. Do not use low temperature solder.
3. Fluxes should be used carefully. Avoid excessive application and do not allow fluxes to enter into the system.
4. Brazing temperature of copper is proper when it is heated to a minimum temperature of 800°F and it is a dull red color in appearance.

This section on brazing is not intended to teach a technician how to braze. There are books and classes which teach and refine brazing techniques. The basic points above are listed only as a reminder.

Step 5—Service Valves and Pumpdown

⚠ WARNING

Never attempt to make repairs to existing service valves. Unit operates under high pressure. Damaged seats and o-rings should not be replaced. Replacement of entire service valve is required. Tampering with damaged valves can cause personal injury or death. Service valve must be replaced by properly trained service technician.

Service valves provide a means for holding original factory charge in outdoor unit prior to hookup to indoor coil. They also contain gage ports for measuring system pressures and provide shutoff convenience for certain types of repairs. (See Fig. 27 and 28.)

Two types of service valves are used in outdoor residential equipment. The first type is a front-seating valve, which has a service port that contains a Schrader fitting. The service port is always pressurized after the valve is moved off the front-seat position.

The second type is a combination front-seating/back-seating valve, which has a metal-to-metal seat in both the open and closed positions. When it is fully back-seated, the service port is not pressurized. To pressurize the service port, this valve must be moved off the back-seating position. This valve does not contain a Schrader fitting. Both types of service valves are designed for sweat connection to the field tubing.

The service valves in the outdoor unit come from the factory front-seated. This means that the refrigerant charge is isolated from the line-set connection ports. Some heat pumps are shipped with sweat-adaptor tube. This tube must be installed on the liquid-service valve. After connecting the sweat adaptor to the liquid-service valve of a heat pump, the valves are ready for brazing. The interconnecting tubing (line set) can be brazed to the service valves using industry accepted methods and materials. Consult local codes.

Before brazing the line set to the valves, the belled ends of the sweat connections on the service valves must be cleaned so that no brass plating remains on either the inside or outside of the bell joint. To prevent damage to the valve and/or cap "O" ring, use a wet cloth or other acceptable heat-sinking material on the valve before brazing. To prevent damage to the unit, use a metal barrier between brazing area and unit.

After the brazing operation and the refrigerant tubing and evaporator coil have been evacuated, the valve stem can be turned counterclockwise until it opens or back-seats, which releases refrigerant into tubing and evaporator coil. The system can now be operated.

Back-seating service valves must be back-seated (turned counterclockwise until seated) before the service-port caps can be removed and hoses of gage manifold connected. In this position, refrigerant has access from and through outdoor and indoor unit.

The service valve-stem cap is tightened to 20 ± 2 ft/lb torque and the service-port caps to 9 ± 2 ft/lb torque. The seating surface of the valve stem has a knife-set edge against which the caps are tightened to attain a metal-to-metal seal. If accessory pressure switches are used, the service valve must be cracked. Then, the knife-set stem cap becomes the primary seal.

The service valve cannot be field repaired; therefore, only a complete valve or valve stem and service-port caps are available for replacement.

If the service valve is to be replaced, a metal barrier must be inserted between the valve and the unit to prevent damaging the unit exterior from the heat of the brazing operations.

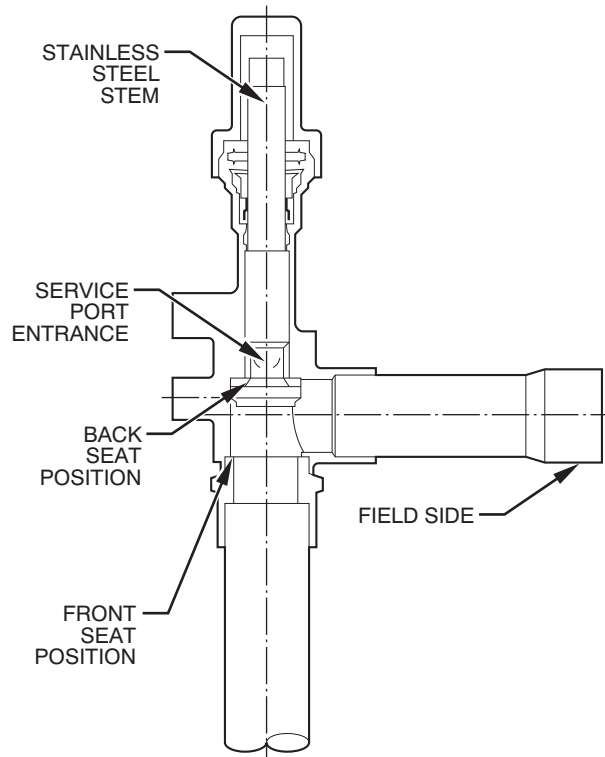
⚠ WARNING

Wear safety glasses and gloves when handling refrigerants. Failure to follow this warning can cause a fire, personal injury, or death.

Pumpdown Procedure

Service valves provide a convenient shutoff valve useful for certain refrigeration-system repairs. System may be pumped down to make repairs on low side without losing complete refrigerant charge.

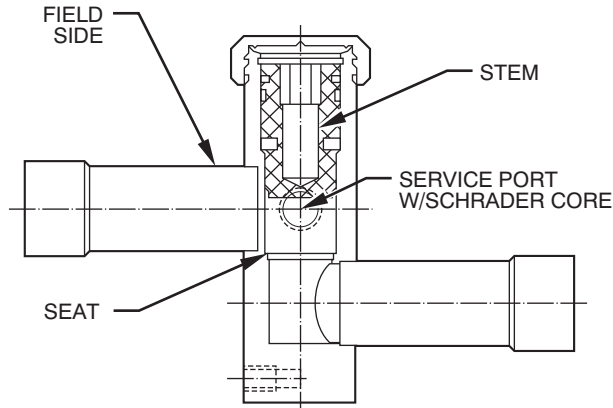
1. Attach pressure gage to suction service-valve gage port.
2. Front seat liquid-line valve.
3. Start unit in cooling mode. Run until suction pressure reaches 5 psig (35kPa). Do not allow compressor to pump to a vacuum.
4. Shut unit off. Front seat suction valve.



FORGED BACK SEATING VALVE

A91435

Fig. 27—Service Valve (Back Seating)



BAR STOCK FRONT SEATING VALVE

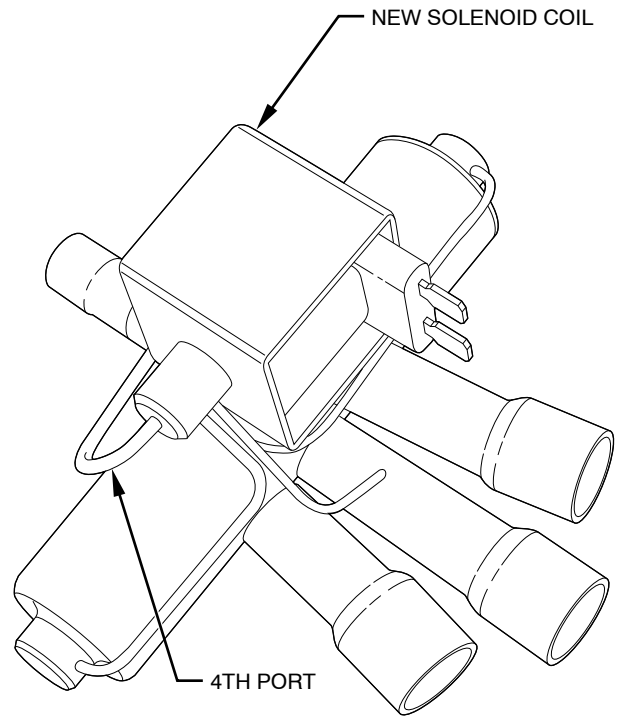
A91447

Fig. 28—Service Valve (Front Seating)

NOTE: All outdoor unit coils will hold only factory-supplied amount of refrigerant. Excess refrigerant, such as in long-line applications, may cause unit to relieve pressure through internal pressure-relief valve (indicated by sudden rise of suction pressure) before suction pressure reaches 5 psig (35kPa). If this occurs, shut off unit immediately, front seat suction valve, and recover remaining pressure.

Step 6—Reversing Valve

In heat pumps, changeover between heating and cooling modes is accomplished with a valve that reverses flow of refrigerant in system. (See Fig. 28.) This reversing valve device is easy to



4 PORT DESIGN

A91456

Fig. 29—Reversing Valve

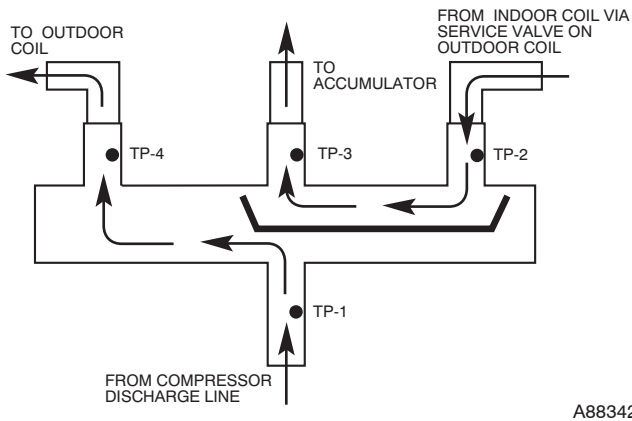
troubleshoot and replace. The reversing valve solenoid can be checked with power off with an ohmmeter. Check for continuity and shorting to ground. With control circuit (24v) power on, check for correct voltage at solenoid coil. Check for overheated solenoid. With unit operating, other items can be checked, such as frost or condensate water on refrigerant lines.

The sound made by a reversing valve as it begins or ends defrost is a “whooshing” sound, as the valve reverses and pressures in system equalize. An experienced service technician detects this sound and uses it as a valuable troubleshooting tool.

Using a remote measuring device, check inlet and outlet line temperatures. DO NOT touch lines. If reversing valve is operating normally, inlet and outlet temperatures on appropriate lines should be close. Any difference would be due to heat loss or gain across valve body. Temperatures are best checked with a remote reading electronic-type thermometer with multiple probes. Route thermocouple leads to inside of coil area through service valve mounting plate area underneath coil. Fig. 30 and 31 show test points (TP) on reversing valve for recording temperatures. Insulate points for more accurate reading.

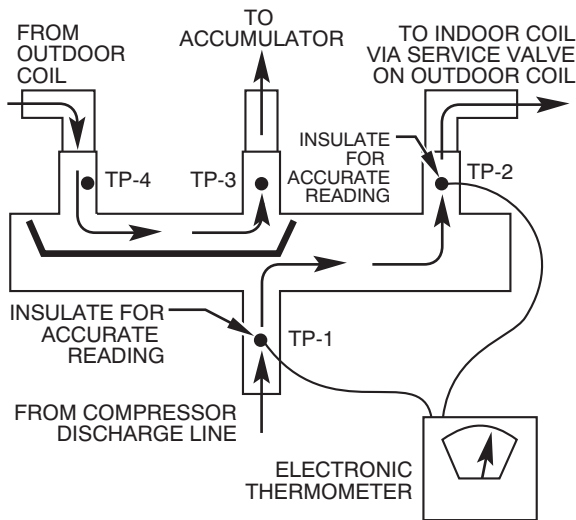
If valve is defective:

1. Shut off all power to unit and remove charge from system.
2. Remove solenoid coil from valve body. Remove valve by cutting it from system with tubing cutter. Repair person should cut in such a way that stubs can be easily rebraced back into system. Do not use hacksaw. This introduces chips into system that cause failure. After defective valve is removed, wrap it in wet rag and carefully unbrace stubs. Save stubs for future use. Because defective valve is not overheated, it can be analyzed for cause of failure when it is returned.
3. Braze new valve onto used stubs. Keep stubs oriented correctly. Scratch corresponding matching marks on old valve and stubs and on new valve body to aid in lining up new valve



A88342

Fig. 30—Reversing Valve (Cooling Mode or Defrost Mode, Solenoid Energized)



A88341

Fig. 31—Reversing Valve (Heating Mode, Solenoid De-Energized)

properly. When brazing stubs into valve, protect valve body with wet rag to prevent overheating.

- Use slip couplings to install new valve with stubs back into system. Even if stubs are long, wrap valve with a wet rag to prevent overheating.
- After valve is brazed in, check for leaks. Evacuate and charge system. Operate system in both modes several times to be sure valve functions properly.

Step 7—Liquid Line Filter Drier

The filter drier is specifically designed to operate with Puron®, use only factory-authorized components. Filter drier must be replaced whenever the refrigerant system is opened. When removing a filter drier, use a tubing cutter to cut the drier from the system. **Do not unsweat a filter drier** from the system. Heat from unsweating will release moisture and contaminants from drier into system.

Step 8—Suction Line Filter Drier

The suction line drier is specifically designed to operate with Puron®, use only factory authorized components. Suction line filter drier is used in cases where acid might occur, such as burnout. Heat pump units must have the drier installed between the compressor and accumulator only. Remove after 10 hours of operation. Never leave suction line filter drier in a system longer than 72 hours (actual time).

Step 9—Accumulator

The accumulator is specifically designed to operate with Puron®, use only factory-authorized components. Under some light load conditions on indoor coils, liquid refrigerant is present in suction gas returning to compressor. The accumulator stores liquid and allows it to boil off into a vapor so it can be safely returned to compressor. Since a compressor is designed to pump refrigerant in its gaseous state, introduction of liquid into it could cause severe damage or total failure of compressor.

The accumulator is a passive device which seldom needs replacing. Occasionally its internal oil return orifice or bleed hole may become plugged. Some oil is contained in refrigerant returning to compressor. It cannot boil off in accumulator with liquid refrigerant. The bleed hole allows a small amount of oil and refrigerant to enter the return line where velocity of refrigerant returns it to compressor. If bleed hole plugs, oil is trapped in accumulator, and compressor will eventually fail from lack of lubrication. If bleed hole is plugged, accumulator must be changed. The accumulator has a fusible element located in the bottom end bell. (See Fig. 32.) This fusible element will melt at 430°F and vent the refrigerant if this temperature is reached either internal or external to the system. If fuse melts, the accumulator must be replaced.

To change accumulator:

- Shut off all power to unit.
- Recover all refrigerant from system.
- Break vacuum with dry nitrogen. Do not exceed 5 psig.

NOTE: Coil may be removed for access to accumulator. Refer to appropriate sections of Service Manual for instructions.

⚠ WARNING

Wear safety glasses and gloves when working on refrigerants and when using brazing torch. Failure to follow this warning can cause a fire, personal injury, or death.

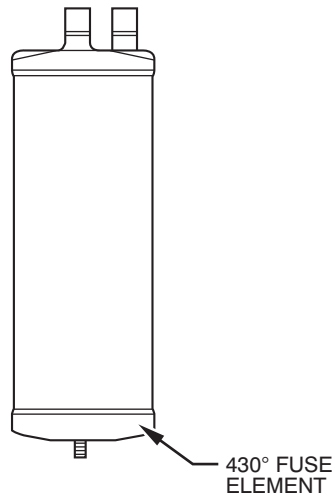
- Remove accumulator from system with tubing cutter.
- Tape ends of open tubing.
- Scratch matching marks on tubing studs and old accumulator. Scratch matching marks on new accumulator. Unbrazed stubs from old accumulator and braze into new accumulator.
- Thoroughly rinse any flux residue from joints and paint with corrosion-resistant coating such as zinc-rich paint.
- Install factory authorized accumulator into system with copper slip couplings.
- Evacuate and charge system.

Pour and measure oil quantity (if any) from old accumulator. If more than 20 percent of oil charge is trapped in accumulator, add new POE oil to compressor to make up for this loss. (See Table 9.)

Step 10—AccuRater®

AccuRater® piston has a refrigerant metering hole through it. The retainer forms a sealing surface for liquid-line flare connection. Any R-22 piston must be replaced with factory approved piston for Puron®. If air conditioner is shipped with a piston ring (located in piston bag) be sure it is installed per Fig. 33. The piston ring will ensure piston stays seated during all operating conditions. For Heat Pumps, piston ring not used at outdoor piston. To check, clean, or replace piston follow these steps: (See Fig. 33.)

- Shut off power to unit.
- Pump unit down using pumpdown procedure described in this service manual.
- Loosen nut and remove liquid line flare connection from AccuRater®.



A88410

Fig. 32—Accumulator

4. Pull retainer out of body, being careful not to scratch flare sealing surface. If retainer does not pull out easily, carefully use locking pliers to remove it.
5. Slide piston and piston ring out by inserting a small soft wire with small kinks through metering hole. Do not damage metering hole, sealing surface around piston cones, or fluted portion of piston.
6. Clean piston refrigerant metering hole.
7. Install a new retainer O-ring, retainer assembly, or Teflon washer before reassembling AccuRater®.

Step 11—Thermostatic Expansion Valve (TXV)

The thermostatic expansion valve is specifically designed to operate with Puron®, use only factory authorized TXV. **Do not use an R-22 TXV.**

Step 12—Hard Shutoff (HSO)

Has no bleed port and allows no bleed through after system shutdown. No pressure equalization occurs.

The TXV is a metering device that is used in air conditioning and heat pump systems to adjust to changing load conditions by maintaining a preset superheat temperature at the outlet of the evaporator coil. The volume of refrigerant metered through the valve seat is dependent upon the following: (See Fig. 37.)

1. Superheat temperature sensed by cap tube sensing bulb on suction tube at outlet of evaporator coil. As long as this bulb and cap tube contains some liquid refrigerant, this temperature is converted into suction pressure pushing downward on the diaphragm, which tends to open the valve via the pushrods.
2. The suction pressure at the outlet of the evaporator coil is transferred via the external equalizer tube to the underside of the diaphragm.
3. The needle valve on the pin carrier is spring loaded, which exerts pressure on the underside of the diaphragm via the pushrods and tends to close the valve. Therefore, bulb pressure equals evaporator pressure (at outlet of coil) plus spring pressure. If the load increases, the temperature increases at the bulb, which increases the pressure on the top side of the diaphragm, which pushes the carrier away from the seat, opening the valve and increasing the flow of refrigerant. The increased refrigerant flow causes increased leaving evaporator pressure which is transferred via the equalizer tube to the underside of the diaphragm. This tends to cause the pin carrier

spring pressure to close the valve. The refrigerant flow is effectively stabilized to the load demand with negligible change in superheat.

Step 13—Replacing R-22 Expansion Device with Puron® TXV

An existing R-22 TXV must be replaced with a factory approved TXV specifically designed for Puron®.

NOTE: All Puron® Heat Pumps require a Puron® hard shutoff TXV.

For existing R-22 TXV Fan Coils and Furnace Coils, the TXV must be replaced with a factory approved TXV specifically designed for Puron®. Fan Coils with internal TXV's may have TXV directly replaced with TXV from kit. Fan coils and furnace coils with pistons, TXV must be located external to cabinet as shown in Fig. 36. See Fig. 35 for proper sensing bulb position and Fig. 36 for proper sensing bulb location. Follow instructions included with Puron® TXV kit for specific details. (See Fig. 34.)

REFRIGERATION SYSTEM REPAIR

Step 1—Leak Detection

New installations should be checked for leaks prior to complete charging.

If a system has lost all or most of its charge, system must be pressurized again to approximately 150 psi minimum and 375 psi maximum. This can be done by adding refrigerant using normal charging procedures or by pressurizing system with nitrogen (less expensive than refrigerant). Nitrogen also leaks faster than Puron. Nitrogen cannot, however, be detected by an electronic leak detector. (See Fig. 38.)

⚠ WARNING

Due to the high pressure of nitrogen, it should never be used without a pressure regulator on the tank. Failure to follow this warning can cause a fire, personal injury, or death.

Assuming that a system is pressurized with either all refrigerant or a mixture of nitrogen and refrigerant, leaks in the system can be found with an electronic leak detector that is capable of detecting HFC refrigerant.

If system has been operating for some time, first check for a leak visually. Since refrigerant carries a small quantity of oil, traces of oil at any joint or connection is an indication that refrigerant is leaking at that point.

A simple and inexpensive method of testing for leaks is to use soap bubbles. (See Fig. 39.) Any solution of water and soap may be used. Soap solution is applied to all joints and connections in system. A small pinhole leak is located by tracing bubbles in soap solution around leak. If the leak is very small, several minutes may pass before a bubble will form. Popular commercial leak detection solutions give better, longer-lasting bubbles and more accurate results than plain soapy water. The bubble solution must be removed from the tubing and fittings after checking for leaks as some solutions may corrode the metal.

You may use an electronic leak detector designed for HFCs to check for leaks. (See Fig. 38.) This unquestionably is the most efficient and easiest method for checking leaks. There are various types of electronic leak detectors. Electronic leak detectors must be suitable for Puron® (HFC) refrigerant. Check with manufacturer of equipment for suitability. Generally speaking, they are portable, lightweight, and consist of a box with several switches and a probe or sniffer. Detector is turned on and probe is passed around all fittings and connections in system. Leak is detected by either the movement of a pointer on detector dial, a buzzing sound, or a light.

In all instances when a leak is found, system charge must be recovered and leak repaired before final charging and operation. After leak testing or leak is repaired, replace liquid line filter drier, evacuate system, and recharge with correct refrigerant quantity.

Step 2—Coil Removal

Coils are easy to remove if required for compressor removal, or to replace coil.

1. Shut off all power to unit.
2. Recover refrigerant from system through service valves.
3. Break vacuum with nitrogen.
4. Remove top cover. (See Remove Top Cover in Cabinet section of the manual.)
5. Remove screws in base pan to coil grille.
6. Remove coil grille from unit.
7. Remove screws on corner post holding coil tube sheet.

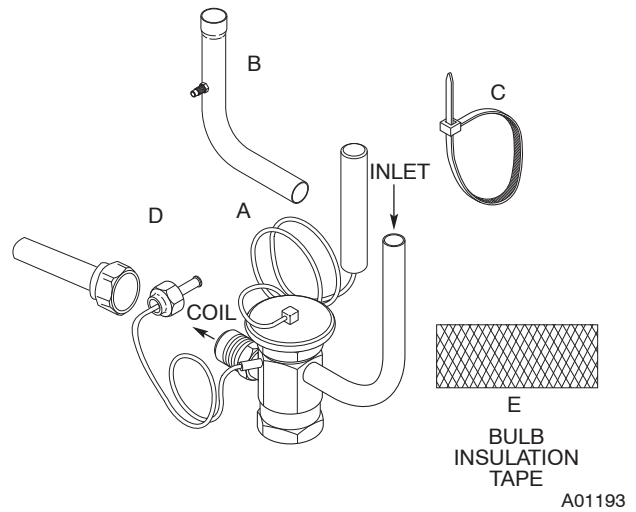


Fig. 34—Puron® TXV Kit Components

⚠ WARNING
Cut tubing to reduce possibility of fire and personal injury.

8. Use midjet tubing cutter to cut liquid and vapor lines at both sides of coil. Cut in convenient location for easy reassembly with copper slip couplings.
9. Lift coil vertically from basepan and carefully place aside.
10. Reverse procedure to reinstall coil.
11. Replace filter drier, evacuate system, recharge, and check for normal systems operation.

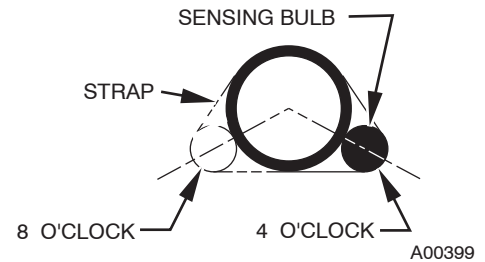


Fig. 35—Position of Sensing Bulb

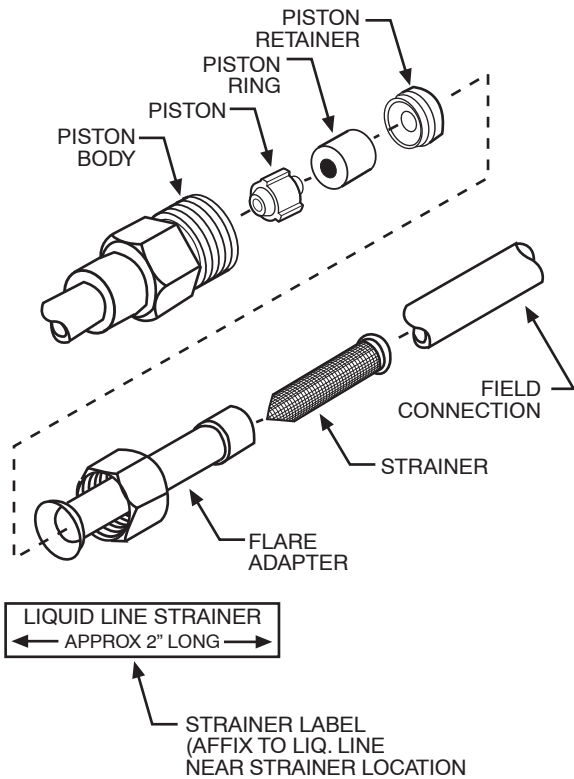


Fig. 33—AccuRater® Components

Step 3—Compressor Removal and Replacement

Once it is determined that compressor has failed and the reason established, compressor must be replaced.

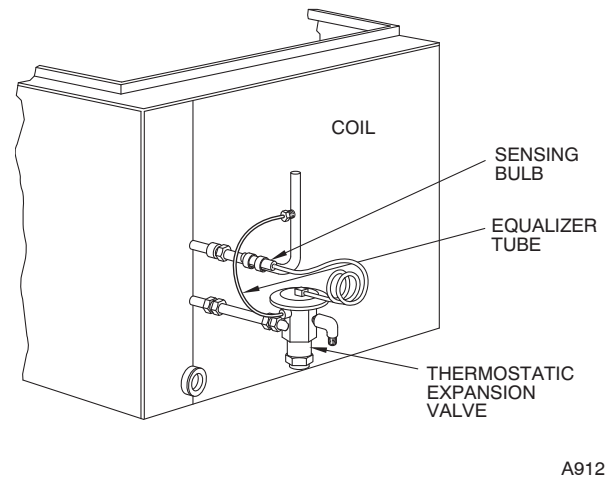
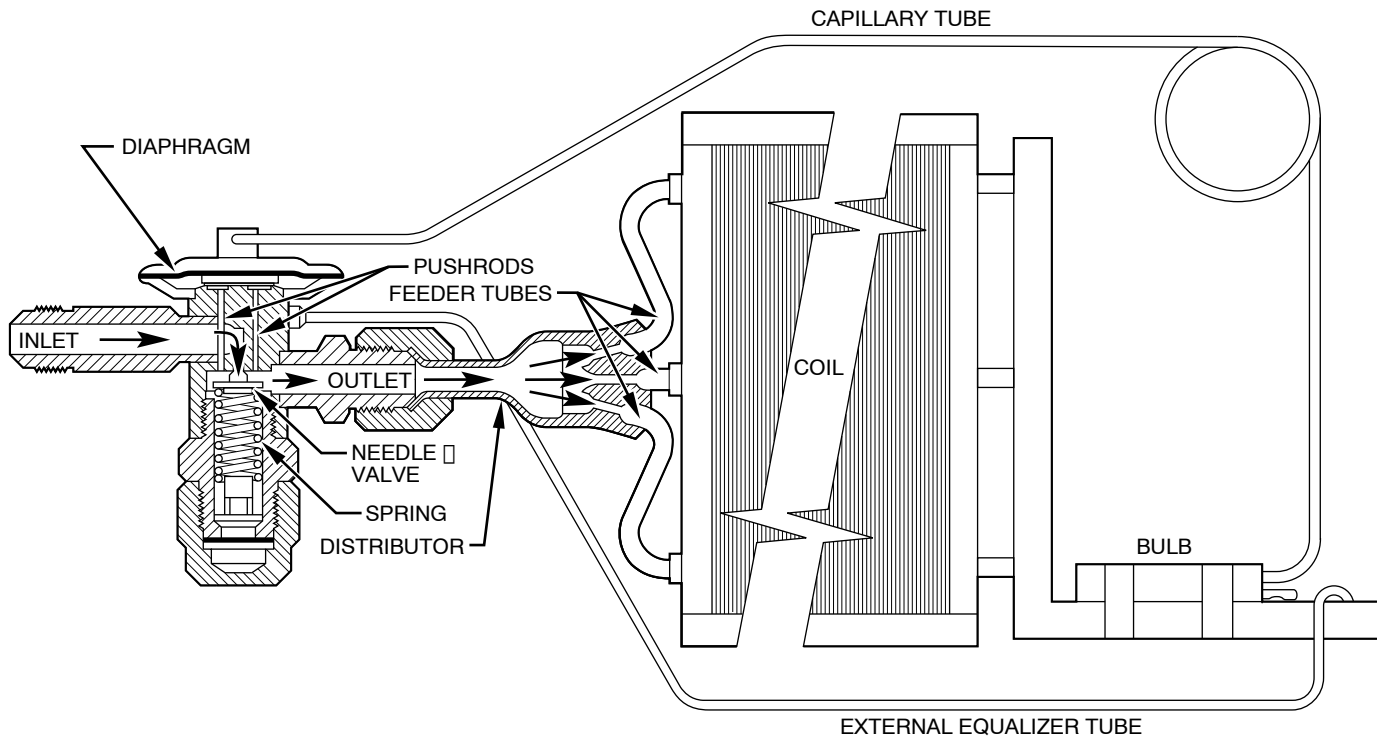


Fig. 36—Typical TXV Installation

⚠ CAUTION
Turn off all power to unit before proceeding. Wear safety glasses and gloves when handling refrigerants. Acids formed as a result of motor burnout can cause burns.

⚠ WARNING
Wear safety glasses and gloves when handling refrigerants and when using brazing torch. Failure to follow this warning can cause a fire, personal injury, or death.

1. Shut off all power to unit.
2. Remove and recover all refrigerant from system until pressure gages read 0 psi. Use all service ports. Never open a system



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Fig. 37—TXV Operation

under a vacuum to atmosphere. Break vacuum with dry nitrogen holding charge first. Do not exceed 5 psig.

3. Disconnect electrical leads from compressor. Disconnect or remove crankcase heater and remove compressor hold-down bolts.
4. Cut compressor from system with tubing cutter. Do not use brazing torch for compressor removal. Oil vapor may ignite when compressor is disconnected.
5. Scratch matching marks on stubs in old compressor. Make corresponding marks on replacement compressor.
6. Use torch to remove stubs from old compressor and to reinstall them in replacement compressor.
7. Use copper couplings to tie compressor back into system.
8. Replace filter drier, evacuate system, recharge, and check for normal system operation.

⚠ CAUTION

Do not leave system open to atmosphere. Product damage could occur. Compressor oil is highly susceptible to moisture absorption.

Step 4—System Clean-Up After Burnout

Some compressor electrical failures can cause motor to burn. When this occurs, by-products of burn, which include sludge, carbon, and acids, contaminate system. Test the oil for acidity using POE oil acid test to determine burnout severity. If burnout is severe enough, system must be cleaned before replacement compressor is installed. The 2 types of motor burnout are classified as mild or severe.

In mild burnout, there is little or no detectable odor. Compressor oil is clear or slightly discolored. An acid test of compressor oil will be negative. This type of failure is treated the same as mechanical failure. Liquid-line strainer should be removed and liquid-line filter drier replaced.

In a severe burnout, there is a strong, pungent, rotten egg odor. Compressor oil is very dark. Evidence of burning may be present in tubing connected to compressor. An acid test of compressor oil will be positive. Follow these additional steps:

1. TXV must be cleaned or replaced.
2. Drain any trapped oil from accumulator if used.
3. Remove and discard liquid-line strainer and filter drier.
4. After system is reassembled, install liquid and suction-line Puron® filter driers.

NOTE: On heat pumps, install suction line drier between compressor and accumulator.

5. Operate system for 10 hr. Monitor pressure drop across drier. If pressure drop exceeds 3 psig replace suction-line and liquid-line filter driers. Be sure to purge system with dry nitrogen when replacing filter driers. If suction line driers must be replaced, retest pressure drop after additional 10 hours (run time). Continue to monitor pressure drop across suction-line filter drier. After 10 hr of run time, remove suction-line filter drier and replace liquid-line filter drier. **Never leave suction-line filter drier in system longer than 72 hr (actual time).**

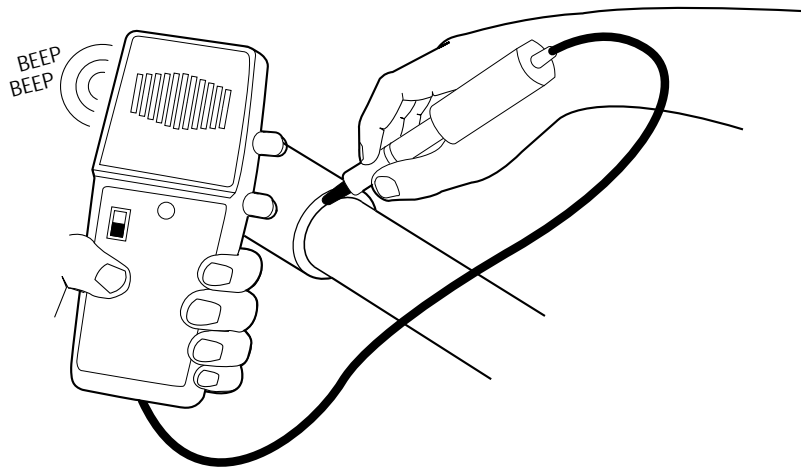
6. Charge system. (See unit information plate.)

Step 5—Evacuation

Proper evacuation of the system will remove non-condensibles and assure a tight, dry system before charging. The 2 methods used to evacuate a system are the deep vacuum method and the triple evacuation method.

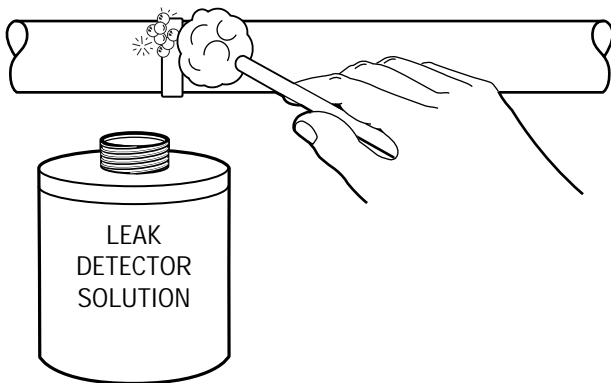
DEEP VACUUM METHOD

The deep vacuum method requires a vacuum pump capable of pulling a vacuum of 500 microns and a vacuum gage capable of accurately measuring this vacuum depth. The deep vacuum method is the most positive way of assuring a system is free of air and moisture. (See Fig. 40.)



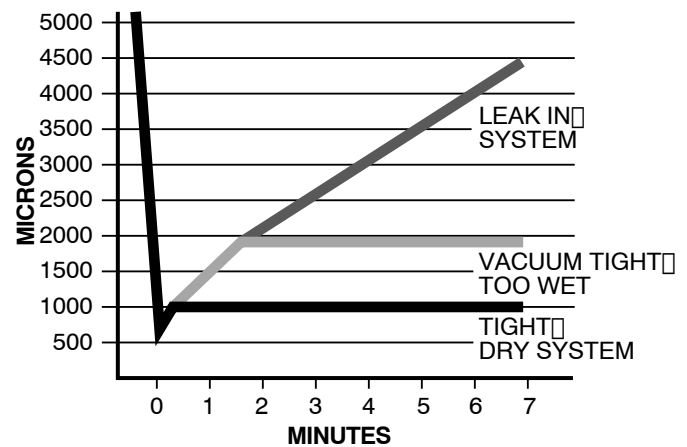
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Fig. 38—Electronic Leak Detection



A95423

Fig. 39—Bubble Leak Detection



A95424

Fig. 40—Deep Vacuum Graph

Step 6—Puron® Refrigerant Charging

Refer to unit information plate for superheat charging procedure. Charge Puron® units with cylinder in upright position and a commercial type metering device in manifold hose. Charge refrigerant into suction-line.

For all approved combinations, system must be charged correctly for normal system operation and reliable operation of components. (See Fig. 41.)

If system has lost all charge, weigh in charge using digital scales.

System charge should be fine tuned by using superheat method or subcooling method as defined by cooling mode metering device.

For charging during heating season, charge must be weighed in accordance with unit rating plate ± 0.6 oz/ft of 3/8 in. liquid line above or below 15 ft respectively.

Step 7—Checking Charge

SUPERHEAT CHARGING METHOD

Superheat charging is the process of charging refrigerant in a system until the temperature (superheat) of suction gas entering compressor reaches a prescribed value. Small variations of charge affect suction gas superheat temperatures greatly. Therefore, this method of charging is very accurate. This method can be used with fixed restrictor type metering devices such as AccuRater. For units using a TXV, the subcooling method must be used. To charge by superheat, a service technician will need an accurate superheat thermocouple or thermistor-type thermometer, a sling psychrometer, and a gage manifold. Do not use mercury or small dial type thermometers as they are not adequate for this type of measurement. Refer to unit information plate for superheat charging procedure.

SUBCOOLING CHARGING METHOD

(See Charging Tables 15 & 16)

1. Operate unit a minimum of 15 minutes before checking charge.
2. Measure liquid service valve pressure by attaching an accurate gage to service port.
3. Measure liquid-line temperature by attaching an accurate thermistor-type or electronic thermometer to liquid line near outdoor coil.
4. Refer to unit information plate to find required subcooling temperature for unit. Find point at which required subcooling temperature intersects measured liquid service valve pressure.
5. Add refrigerant if liquid-line temperature is higher than indicated. Remove refrigerant if temperature is lower. Allow a tolerance of 3°F.

Step 8—TWO-SPEED

APPLICATION GUIDELINES

Carrier designed and tested Puron® two-speed air conditioner and heat pump products operate in a range of 55° to 125°F ambient for cooling and -30° to 66°F ambient for heating.

Hot gas by-pass and 100 percent outdoor air applications are not approved on this or any Carrier split-system residential product.

The Puron® two-speed products like all Puron® products are shipped with a filter drier to be installed in the field liquid line.

All Puron® two-speed air conditioners and heat pumps require a Balance Port Thermal Expansion Valve (TXV), be used as the metering device on the indoor coil for cooling applications. The TXV is not shipped with the outdoor unit, it is field supplied. Consult the presale literature for proper sizing of the TXV.

The indoor coil/fan coil may have to be replaced to an approved combination listed in the product literature or ARI directory.

Line sets for the Puron two-speed air conditioners are similar to those used on existing R-22 and Puron units. Line sets for the Puron two-speed heat pumps are similar to the Puron single speed heat pump units.

Carrier thermostats, thermostats, and zone controls are recommended control devices. All the logic for sequence control of the Puron® two-speed products are contained within the thermostats and zoning controls.

The Tennessee Valley Authority (TVA) requires that the electric strip heat have a lockout feature. This is achieved through the corporate thermostat or zone control, and must be used on all TVA approved units.

The new control board in the Puron two-speed air conditioner and heat pump units does not contain or require the high speed latching, balance point, or defrost time potentiometers. The balance point was for dual fuel application which can now be done using the Thermostat or Dual Fuel Thermostat.

The defrost timer is now activated using two dip switches.

The Puron® two-speed heat pump units cannot use the fan coil Super Comfort Heat™ mode in conjunction with the use of PressureGuard™. The pressure guard is designed to insure that the head pressure during heating mode operation does not exceed the pressure limits of standard line sets. Enabling Super Comfort Heat™ mode on the fan coil slows the indoor fan down and increases the head pressure. Super Comfort Heat™ operation at high ambient temperatures may cause the PressureGuard™ switch to cycle. Cycling PressureGuard™ defeats the functionality of Super Comfort Heat™ operation.

The Puron two-speed units are not approved for low ambient applications.

Long line application requirements are similar to those on the single speed Puron refrigerant units. See the Long Line Guideline in Table of Contents.

SAFETY REVIEW

Only qualified technicians should install or service this product.

Whenever possible, shut off all power before working on electrical equipment.

If you must work on energized electrical equipment, remove all watches and rings to minimize shock hazards.

Wear Safety glasses and gloves when handling refrigerants or brazing.

Never vent refrigerant to the atmosphere. Recover or reclaim refrigerant using approved recovery equipment for use on Puron® refrigerant.

These are some general safety procedures. Always read and follow specific procedures in the manufacturers installation and service literature.

MAJOR COMPONENTS

Filter Drier

All Puron® two-speed air conditioners and heat pumps are shipped with a filter drier designed for Puron®. The air conditioners use a single flow filter drier while the heat pumps use a bi-flow drier. The drier **MUST** be installed in the liquid line.

Thermal Expansion Valve (TXV)

For Puron® two-speed air conditioners and heat pumps a hard shutoff, bi-flow TXV specifically designed for Puron, and two-speed operation must be used as the indoor coil metering device.

If a 40FKA or FV4A fan coil is used, the TXV must also be changed. Although these two families of fan coils are designed for Puron® applications, currently the factory installed TXV does not have the capability to meet the capacity ranges required for the two-speed unit. See the product literature for TXV requirements.

Fan Motor

Fan motor rotates the fan blade that either draws or blows air through outdoor coil to perform heat exchange. Motors are totally enclosed to increase reliability. This also eliminates need for rain shield.

⚠ WARNING

Turn off all power to unit before servicing or replacing fan motor. Be sure unit main power switch is turned off. Failure to do so may result in electric shock, death, or injury from rotating fan blade.

The bearings are permanently lubricated; therefore, no oil ports are provided.

For suspected electrical failures, check for loose or faulty electrical connections, or defective fan-motor capacitor. Fan motor is equipped with thermal overload device in motor windings which may open under adverse operating conditions. Allow time for motor to cool so device can reset. Further checking of motor can be done with an ohmmeter. Set scale on R X 1 position; check for continuity between three leads. Replace motors that show an open circuit in any of the windings. Place 1 lead of ohmmeter on each motor lead. At same time, place other ohmmeter lead on motor case (ground). Replace any motor that shows resistance to ground, signs of arcing, burning, or overheating.

Located above the compressor is a single-speed fan motor and fan. This is not the case on the 037 size air conditioner and heat pump models, which use the ICM variable speed fan motor.

ICM FAN MOTOR—Only the 037 size air conditioner and heat pump models have the ICM variable speed fan motor.

The outdoor Integral Control Motor (ICM), is a variable-speed motor which operates from 400 to 900 rpm. The motor is a dc permanent magnet-type motor with the electronic controls integrated into its rear cover. The control package includes a small diode bridge, capacitors, and power switching devices. It converts ac to dc power and switches the dc power to the motor windings on and off at various rates to control the motor speed. The speed at which the motor windings are thus commutated is determined by a pulse width modulated (PWM) signal which is received from the control board on the motor control lines.

The PWM signal is created by turning a DC signal on and off once within a given period of time. The signal on time relative to the signal total period defines the percent of the PWM. For example, if the period is 5 sec and the control power is turned on for 1 sec

then off, the signal will remain off for 4 sec before turning on again to start the next cycle. The PWM is called a 20 percent duty cycle signal. If the on time is increased to 4 sec of the 5 sec period, the PWM is called an 80 percent duty cycle. The ICM reads the PWM signal and increases the motor speed linearly from minimum speed to maximum speed with the percent duty cycle value of the supplied PWM signal.

FAN MOTOR OPERATION

The two-speed control board energizes the outdoor fan motor anytime the compressor is operating. The outdoor fan motor remains energized during the one minute compressor speed changeover or if the pressure switches should open.

After the termination of a defrost cycle on the heat pump models, the outdoor fan motor delays coming on for 20 seconds. This allows the refrigerant system to recover the outdoor coil heat and minimize the “steam cloud” effect.

Compressor

Although the Bristol reciprocating compressor may look like any other reciprocating compressor, the compressor is specifically designed for Puron® higher operating pressures and two-speed operation. This model of compressor uses a required oil known as MCP-2134 POE, a polyolester lubricating oil with additive that is compatible with the new refrigerant. Should the compressor require replacement, use only the manufacturer-specified replacement.

The Bristol two-speed compressor relies on the reverse rotation of the hermetic motor to idle one of the two pistons to provide reduced capacity. The Bristol two-speed reciprocating compressor while running in the clockwise rotation activates both pistons. When the motor is running in the counterclockwise rotation the cam and clutch mechanism idles one of the pistons, thus reducing the capacity of the compressor. The motor RPM does not change appreciably between single or two piston operation.

Compressor Vc/Vh

The two-speed Puron units have a Vc/Vh thermal trip device. The control board monitors the compressor capacitor voltage and when voltage is below 90vac or above 600vac the control board will cutoff current flow to the contactor coil and shutdown. A fault light will appear on the control board. Fault lights and their meanings will be covered later in this program.

Pressure Switches

The Puron® two-speed air conditioner contains two pressure switches to prevent system operation if the pressures get excessively high or low. The air conditioner low pressure switch in the suction line opens at 50 PSI and closes at 95 PSI. The high pressure switch opens at 610 PSI and closes at 420 PSI. Both pressure switch settings are considerably higher than on comparably sized R-22 units. The high and low pressure switches can be identified by their pink stripe on the switch’s electrical wires.

The Puron two-speed heat pump contains a loss of charge switch in the liquid line which opens at 23 PSI and closes at 55 PSI.

Table 12—PressureGuard™ Control Settings

UNIT SIZE	PART NUMBER	CUT OUT	CUT IN
024	HK02ZB325	400	325
036	HK02ZB309	384	309
037	HK02ZB325	400	325
048	HK02ZB325	400	325
060	HK02ZB300	374	300

PressureGuard™ (VPS)

The Puron two-speed heat pump contains a pressure guard (labeled VPS which stands for Vapor Pressure Switch) in the vapor line. PressureGuard, or VPS, keeps the system pressures from exceeding certain values during heating operation. This device allows the Puron two-speed heat pump to be installed on today’s indoor coils and in most cases on today’s interconnecting tubing. Remember only certain indoor coil/fan coil combinations will work properly. Consult the presale literature for approved combinations. Cut in and cut out values for the Pressure Guard are shown in Table 12. The PressureGuard has solid black leads.

Here is how the Vapor Pressure Switch (VPS) works. Under certain high-ambient operating conditions during the heating operation, the vapor pressure in a normally operating system may exceed the pressure setting of the device. This excess pressure will open the switch. The switch is in series with the outdoor fan motor and will shut the fan motor off. With the outdoor fan off, less heat will be absorbed in the outdoor coil and the system pressures will drop. When the outdoor fan is off, frost may accumulate. This can cause the system to have shorter time intervals between defrost cycles.

⚠ CAUTION

The PressureGuard device (VPS) is in the high voltage (230 volt) circuit. It is not in the low or control voltage (24 volt) circuit as are other pressure switches in the unit. Use caution when working near this switch in an operating unit.

Muffler, Accumulator, Reversing Valve (RVS)

The Puron two-speed air conditioners and heat pumps have a compressor discharge line muffler, to dampen sound pressure pulsations.

The Puron two-speed heat pumps have a specifically designed reversing valve, for Puron® application and an accumulator for storing excess liquid refrigerant during the heating mode to prevent damaging flood-back.

Thermistor

Outdoor Ambient

The Puron two-speed air conditioner and heat pump units have an outdoor ambient air thermistor. The control board must know the outdoor air temperature so it can activate various functions. These functions include:

- Activating the compressor crankcase heater when ever the outdoor unit is in the off cycle.
- The fan motor speed changes for both air conditioner and heat pump on the 037 unit.

Outdoor Coil Thermistor(OCT)

The coil or defrost thermistor is the same thermistor used to monitor outdoor air temperature. The control board must know the coil temperature so it can activate various functions. These functions include:

- Frost sensing on heat pumps
- Coil-vs-Ambient temperature relationship

Thermistor Curve

The resistance vs. temperature chart enables the service technicians to check thermistor resistance, regardless of the temperature. For example, at a 60°F temperature, thermistor resistance should be around 16,000 Ohms. (See Fig. 41.)

We will talk about the thermistor in more detail when we review the control board fault codes.

Control Box

Contactor And Capacitor

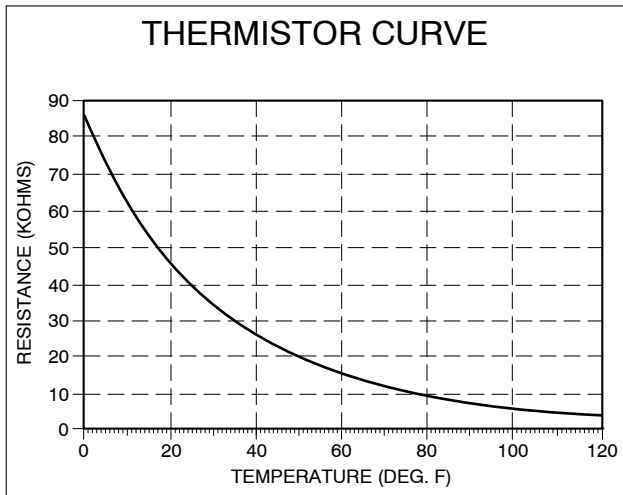


Fig. 41—Resistance Values Versus Temperature

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Removal of the information plate exposes the control components. Both air conditioner and heat pump control boxes will appear to be nearly identical. There are two contactors, two capacitors, a control board and a compressor start assist device called Puron® Kick-Start™. The contactors are identical to those used in the standard single speed units. One controls low capacity operation and the second controls high speed. The capacitors also are similar to those used in standard single speed units. You have a fan capacitor for the outdoor fan motor, and a run capacitor for the compressor motor. The control board and Puron Kick-Start™ will be covered momentarily.

Always replace these devices with the Factory Approved Components.

Incoming Power

Incoming power is attached to the two power wire stripped leads. A ground lug is also provided. Outdoor unit should always be grounded through the ground lug to the unit disconnect and from the disconnect to the electrical fuse box. Failure to do so can cause serious injury or death.

Kick-Start

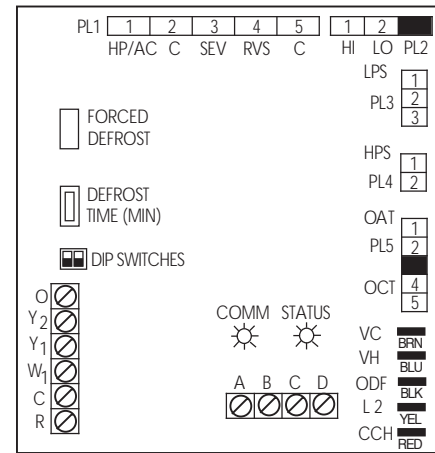
The Puron® Kick-Start™ device is similar to a hard start capacitor and relay used on standard single speed units when extra starting capacitance is required to start the compressor motor. What makes this start assist special is that it takes only one relay and capacitor to start the compressor in both low and high speed. These components are unique to the two-speed product and can not be substituted by standard hard start components for single speed units.

Control Board

The new two-speed control board is smaller and has less components than the older two speed control. This control requires no configuration plug, has no high speed latching pot and requires less troubleshooting. Let's review some of the features of this control.

Jumpers and Plugs

The two-speed control has five (5) jumpers or plugs which are used at the factory and by the field. Connections to the control by the factory are from various components within the unit such as crankcase heater, low and high pressure switches, air temperature and outdoor coil thermistors. (See Fig. 42.) Lets review the jumpers and their connections:



A00428

Fig. 42—Control Board

- PL1 – Terminals 1 & 2 are used to configure the board for air conditioner or heat pump. Terminal 3 is for future use. Terminals 4 & 5 are for heat pump reversing valve coil connections.
- PL2 – Terminal 1 connection is for high capacity contactor 24 volt coil. Terminal 2 connection is for low capacity contactor 24-volt coil.
- PL3 – Low Pressure switch terminals.
- PL4 – High Pressure switch terminals.
- PL5 – Terminals are for the Outdoor Air (OAT) and Outdoor Coil (and Defrost) (OCT) thermistors.

Screw Terminals

There are two (2) screw terminal blocks on the control board. Terminal block labeled A through D is for future use. The terminal block with six (6) screw connections is for the field low voltage wiring. It is labeled O, Y2, Y1, W1, C, R in descending order.

Dip Switches

There are two dip switches used to set the defrost timer interval or the run time between defrost checks. It is factory set at 90 minutes and can be changed to 30, 60, or 120 minute intervals.

Defrost Timer

By setting the dip switches as shown in Table 13, the time interval between defrost checks can be changed.

There are 4 settings and the factory setting is at 90 minutes.

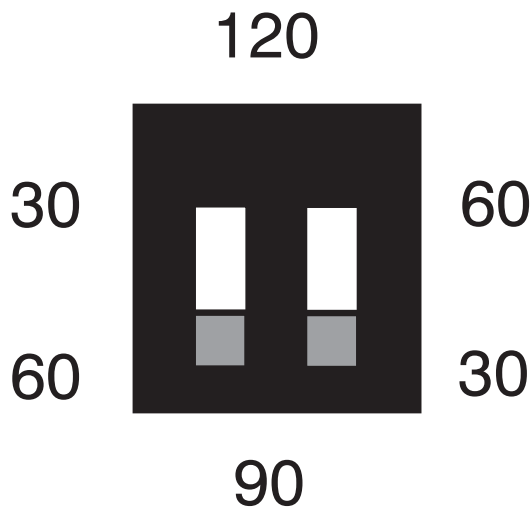
To change the timer from 90 minutes to the new 120 minute interval, move both dip switches to the “ON” position as shown in the Table 13.

To change the timer from 90 to 30 minutes, move dip switch 1 to the “ON” position while leaving dip switch 2 in the “OFF” position. To change the timer from 90 to 60 minutes, move dip switch 2 to the “ON” position while leaving dip switch 1 in the “OFF” position. (See Fig. 43 and Table 13.)

Forced Defrost

The defrost cycle can be initiated by shorting out the “Forced Defrost” terminals for five seconds with a flat bladed screw driver. After the five seconds has elapsed, remove the blade and the defrost cycle will start. There is no need to place a jumper across the “R” to “DFT” on the control board as needed on the standard single speed defrost controls.

The unit will defrost for 30 seconds and then check the defrost thermistor, if the defrost thermistor is indicating a need to defrost, the unit will continue until the defrost cycle is completed. If the defrost thermistor indicates no defrost is necessary the defrost cycle will be terminated.



A00429

Fig. 43—Defrost Timer

Table 13—Switch Settings for Defrost Intervals

SW 1	SW 2	DEFROST TIME (MINUTES)
On	Off	30
Off	On	60
Off	Off	90
On	On	120

Defrost Time/Temperature

The unit will initiate a defrost cycle if the coil temperature is below 30°F, the outdoor temperature is less than 50°F and the time function is met.

The unit will complete the defrost cycle using the standard time/temperature method used on all single speed pump units. Defrost will terminate if the coil temperature exceeds 85°F or if a ten minute defrost time is achieved, whichever occurs first.

When the defrost cycle is terminated the unit will shift back into the heating mode. The outdoor fan motor will have a delayed start time of twenty seconds. This feature allows moisture to drain away from the unit so it will not refreeze on the coil surface and helps to maximize the heat transfer for heating mode restart. It may also minimize the fogging or misting that occurs as the unit comes out of defrost and returns to the heating mode.

LED FUNCTION/MALFUNCTION LIGHTS

An LED indicator light informs the service technician of the current status of the unit.

There are nine (9) codes that indicate faults as well as operational modes and a board failure mode.

Led Function Light Codes

- A constant flash with no pause indicates the unit is in the standby mode. That is, the thermostat is satisfied and the unit is ready to respond to call for heating or cooling.
- One flash with a pause between indicates the unit is in low speed mode.
- Two flashes with a pause between indicates the unit is in high speed mode.
- Three flashes with a pause between indicates a failure of the outdoor air temperature thermistor.
- Four flashes with a pause between indicates a failure of the outdoor coil thermistor.
- Three/Four flashes with a pause between indicates that the thermistors are out of range. We will review the out of range settings on the next slide.

- Five flashes, a momentary pause, plus one additional flash with a pause between indicates the low pressure switch is open. Five flashes, a momentary pause, plus two additional flashes with a pause between indicates the high pressure switch is open.
- Six flashes with a pause between indicates the Vc/Vh has shut the compressor down.
- If the light is on constantly with no flashes or no pauses, it indicates the board has failed and must be replaced.

3/4 Fault

In Cooling – If the outdoor thermistor indicates greater than 10°F or more than the coil thermistor -OR- the outdoor thermistor indicates lower than 20°F the coil thermistor, the thermistors are out of range.

In Heating – If the outdoor thermistor indicates greater than 30°F or more than the coil/defrost thermistor -OR- the outdoor thermistor indicates lower than 10°F or more than the coil/defrost thermistor, the thermistors are out of range.

Compressor Vc/Vh Trip

Six (6) flashes represent a compressor thermal trip. This trip code monitors the voltage at the compressor capacitor to verify the compressor voltage is in the proper range. If the voltage drops below 90 volts or above 600 volts, a fault of 6 flashes will be generated and the compressor will lock-out.

- Compressor Thermal Trip (replaces PTC trip)
- Board Monitors Compressor Capacitor Voltage and when Voltage drops below 90VAC or Above 600VAC, Fault will Occur.

SEQUENCE OF OPERATION

1st Stage (Low Capacity Cooling)

With a call for first stage cooling for Puron® two-speed air conditioners and heat pumps, following is the unit sequence. A call from the indoor thermostat is initiated, 24 volt control power is applied to “Y1” and “O”. “Y1” will tell the control to start the compressor for low capacity operation while “O” tells the control to shift the reversing valve on the heat pump models to the cooling position.

If the unit has been off for more than 12 hours, it will start in high capacity for five minutes, regardless of the capacity being called for. This will quickly clear any liquid that may have accumulated in the compressor.

2nd Stage (High Capacity Cooling)

Second stage cooling or high capacity cooling is achieved when a call from the indoor thermostat is initiated and 24 volt control power is applied to “Y1”, “Y2”, and “O” (heat pump only). “Y2” will tell the control to start the compressor for high capacity operation, while “O” tells the control to shift the reversing valve on the heat pump models to the cooling position.

Note that the system can start in low or high capacity cooling. If the unit is running and a change in capacity is called for, the compressor will shutdown for one minute between cycles. The outdoor fan motor will continue to operate between these one minute shutdown cycles.

The 037 size model with its variable speed outdoor fan motor will continue to operate and will change to the desired speed at the beginning of the one minute shutdown cycle.

1st Stage (Low Capacity Heating)—H/P Only

The unit sequence of operation for the first stage heating for the Puron® two-speed heat pumps begins with a call from the indoor thermostat, then 24 volt control power is applied to “Y1”. “Y1” will tell the control to start the compressor for low capacity

Table 14—Function Light Codes

FUNCTION LIGHT (LED) CODE	DEFINITION
Constant Flash/No Pause. . .	No demand/stand by, Lowest Priority
1 Flash with Pause	Low capacity operation
2 Flashes with Pause	High capacity operation
3 Flashes with Pause	Outdoor thermistor failure
Alternate 3 & 4 flashes	Thermistor out of range
Alternate 5 & 1 flashes	Low pressure switch trip
Alternate 5 & 2 flashes	High pressure switch trip
Alternate 6 flashes	Compressor Vc/Vh trip
Constant light	Board failure, Highest Priority

operation. Because there is no “O” signal telling the control to shift the reversing valve, the reversing valve remains in the heating position.

2nd Stage (High Capacity Heating)—H/P Only

Second stage heating or high capacity heating is achieved when a call from the indoor thermostat is initiated and 24 volt control power is applied to “Y1” and “Y2”. “Y2” will tell the control to start the compressor for high capacity operation. Because there is no “O” signal telling the control to shift the reversing valve, the reversing valve remains in the heating position.

Note that the system can start in low or high capacity heating. If the unit is running and a change in capacity is called for the compressor will shutdown for one minute between cycles. The outdoor fan motor will continue to operate between these one minute shutdown cycles.

The 037 size model with its variable speed outdoor fan motor will continue to operate and will change to the desired speed at the beginning of the one minute shutdown cycle.

The outdoor fan motor works in the heating mode in the same manner as the cooling mode, with the exception of the Pressure Guard cycling the fan motor during heating operation.

3rd Stage (High Capacity Heating)—H/P Only

Third stage heating is high capacity heating with first stage strip heat. This is achieved when a call from the indoor thermostat is initiated and 24 volt control power is applied to “Y1”, “Y2”, and “W1”. “Y2” will tell the control to start the compressor for high capacity operation. Because there is no “O” signal telling the control to shift the reversing valve, the reversing valve remains in the heating position.

First stage strip heat is achieved when “W1” initiates 24 volt control power to the fan coil heater element.

4th Stage (High Capacity Heating)—H/P Only

Fourth stage heating is high capacity heating with second stage strip heat. This is achieved when a call from the indoor thermostat is initiated and 24 volt control power is applied to “Y1”, “Y2”, and “W2”. “Y2” will tell the control to start the compressor for high capacity operation. Because there is no “O” signal telling the control to shift the reversing valve, the reversing valve remains in the heating position.

Staging the strip heater can be accomplished by wiring the heater using “W1” and “W2” terminal and splitting the heater elements on the fan coil unit. A typical 15 KW heater will have three 5 KW elements. By connecting “W1” to 5 KW and “W2” to the remaining 10 KW you can now stage the strip heat and provide the customer with a more comfortable and efficient heating mode.

As per in the last example “W2” was wired to 10 of the 15 KW available in the strip heater, second stage strip heat is achieved when “W2” initiates 24 volt control power to the fan coil heater, the 10 KW element power up.

5th Stage (High Capacity Heating)—H/P Only

Fifth stage heating is high capacity heating with three stage strip heat. This is achieved when a call from the indoor thermostat is initiated and 24 volt control power is applied to “Y1”, “Y2”, “W1”, and “W2”. “Y2” will tell the control to start the compressor for high capacity operation. Because there is no “O” signal telling the control to shift the reversing valve, the reversing valve remains in the heating position.

Again using the 15 KW heater as an example, third stage strip heat is achieved when “W1” and “W2” initiates 24 volt control power to the fan coil heater, the “W1” 5 KW and “W2” 10 KW elements are power up giving you the full 15 KW the heat package can achieve.

TROUBLESHOOTING

NOTE: The wiring diagrams shown in the following paragraphs are simplified versions of actual wiring diagrams found in Puron® air conditioners and heat pumps. The first operation sequence shown is for the air conditioning followed by the heat pump operating sequence. Both wiring diagrams contain optional components.

We will cover only the Heat Pump operation of the two-speed unit. This will cover how the air conditioning system works in the cooling mode of the heat pump.

This sequence shows the unit in standby or ready to start condition:

Step 1—Low voltage reading will be at the Common (“C”) and the Power/24Vac (“R”) terminals.

Step 2—High voltage readings should be taken at the HIGH capacity contactor (terminals 23 and 21). To verify that the crankcase heater is operating, check voltage at the “CL” (terminal 11) and CCH terminals. If 230 volts is present, then the compressor casing should feel warm.

Step 3—If a jumper is installed between “HP/AC” and “common”, the wiring harness is setup for Heat Pump operation. If there is no jumper, then the wiring harness is setup for Air Conditioning operation and the Defrost mode operation is disabled.

NOTE: The crankcase heater (CCH) is energized ANYTIME the compressor is off (regardless of outdoor temperature).

This sequence shows the compressor ready to start in LOW capacity operation. (NOTE: Fan motor operation shown on separate slide.)

Step 1—The signal for the Reversing Valve (“O” terminal) comes from the indoor thermostat. The circuit board will then send a 24 volt signal out to the reversing valve (terminals “RVS” and “C”).

Step 2—The first stage cooling (“Y1”) comes from the indoor thermostat. The circuit board will then send a 24 volt signal out to the LOW capacity contactor coil (“CL”).

Step 3—This will close the contactor, which will send a signal to the compressor “S” terminal and eventually to the “R” terminal, via the start components.

Step 4—The Hard Start Capacitor and Relay will only be in the circuit for a short time and will be the power to keep the compressor running.

Compressor NOTE: The “S” and “R” terminals on the compressor are NOT your traditional START and RUN terminals. This type of compressor acts as a “Balanced Winding” type motor (similar to reversible rotation blower motor). HIGH capacity will cause the compressor to run in one direction while LOW will cause the motor to run in the opposite direction, thus reversing the traditional sense of the “S” and “R” terminals.

This sequence shows the compressor ready to shift to HIGH capacity operation (NOTE: the condenser fan motor will be running during the switch from LOW to HIGH operation). There is a one minute delay between LOW and HIGH capacity.

Step 1—The signal comes from the indoor thermostat to the second stage cooling, terminal “Y2”. This will send a 24 volt signal to the HIGH capacity contactor coil (CH) and close the contactor.

Step 2—With the contactor closed high voltage will be sent to the “R” terminal and eventually to the “S” terminal, via the start components.

Step 3—The Hard Start Capacitor and Relay will only be the circuit for a short time and will be the power to keep the compressor running.

The condenser fan motor receives power from the closing of a relay in the circuit board. If the unit is calling for the condenser fan motor, apply a meter across terminals “CL” (terminal 11) and “ODF”. The reading should be 230 volts.

If the LOW (LPS) or HIGH (HPS) Pressure Switch opens, the condenser fan will continue to run for up to fifteen (15) minutes. If the switches have NOT closed after 15 minutes, the condenser fan will stop running. A fault code of either alternate 5 & 1 or alternate 5 & 2 flashes will occur.

If the system is a heat pump and in the heat pump operation, the condenser fan can be turned off two different ways while the compressor is running in the heating mode. One scenario is if the unit goes into defrost. The circuit opens the fan relay so the coil can defrost quickly. The other scenario is if the Pressure Guard (VPS) cycles (see previous VPS description and operation in the Pressure Guard (VPS) section). During cooling operation the VPS is in the vapor line (low pressure) which keeps the VPS from cycling off the condenser fan.

NOTE: The condenser fan will run during the switching from LOW to HIGH or HIGH to LOW capacity operation. On Heat Pump versions, there is a 20 second fan delay at the termination of the defrost mode.

During heating operation, frost may form on the outdoor coil as part of normal operation. This frost must be periodically removed for efficient operation. The Puron® heat pump uses the reliable time/temperature method. Service Technicians can select a 30, 60, 90, or 120 minute intervals between defrosts. From the factory, the control is set at a 90 minute defrost interval. Other conditions **MUST** also be met. The Outdoor Air Thermistor (OAT) **MUST** read below 50° before the unit will be allowed to go into defrost. The Outdoor Coil Thermistor (OCT) temperature must be 30° or colder to allow the unit to go into defrost.

The defrost sequence is initiated by time AND temperature and terminated by time OR temperature. Having the right conditions of **ONLY** time or temperature will **NOT** initiate defrost, both conditions must be met. Termination, however, can take place whenever conditions of **EITHER** time or temperature have been met.

Once the system has determined a defrost is needed, the heat pump’s circuit board energizes the reversing valve (RVS) and de-energizes the condenser fan motor. If the “W1” wire is hooked-up to the indoor section, 24 volts will be sent to energize supplemental heat.

NOTE: If certain thermostats are used (TSTATCCPDF01-B, TSTATCCPRH01-B and CZII-zoning), the “O” signal generated from the heat pump board is sensed at the thermostat and will assure that the unit will complete its defrost. The “RH” and CZII-zoning also have the option (option 12) to bring on “W” signals from the thermostat. If this option is used, no wire from the heat pump “W1” signal is required. Check thermostat literature for more information.

Troubleshooting the Two-Speed Compressor Start Assist

Start the compressor in Low Speed. The starting amperage should fall below 12 amps within 5 sec. If, after 5 sec, the amperage **exceeds** 12 amps and the start relay does not release, the compressor will open the thermal overload and will be locked out by the control board. The control board display will show Vc/Vh. When this occurs, replace the start assist components.

CARE AND MAINTENANCE

To assure high performance and minimize possible equipment malfunction, it is essential that maintenance be performed periodically on this equipment. The frequency with which maintenance is performed is dependent on such factors as hours of operation, geographic location, and local environmental conditions.

⚠ WARNING

Disconnect all electrical power to unit before performing any maintenance or service on outdoor unit. Remember to disconnect power supply to air handler as this unit supplies low-voltage power to the outdoor unit. Failure to follow this warning can cause a fire, personal injury, or death.

The minimum maintenance that should be performed on this equipment is as follows:

1. Check outdoor coil for cleanliness each heating and cooling season and clean as necessary.
2. Check fan motor and blade for cleanliness each month during cooling season and clean as necessary.
3. Check electrical connections for tightness and controls for proper operation each cooling season and service as necessary.

⚠ CAUTION

Because of possible damage to the equipment or personal injury, maintenance should be performed by qualified personnel only.

Step 1—Cleaning

CLEANING COIL

1. Remove top cover. (See Remove Top Cover in Cabinet section of this manual.)

⚠ CAUTION

Coil fin damage can result in higher operating costs or compressor damage. Do not use flame, high-pressure water, steam, volatile or corrosive cleaners on fins or tubing.

2. Clean coil using vacuum cleaner and its crevice tool. Move crevice tool vertically, close to area being cleaned, making sure tool touches only dirt on fins and not fins. To prevent fin damage, do not scrub fins with tool or move tool horizontally against fins.

3. If oil deposits are present, spray coil with ordinary household detergent. Wait 10 minutes, and proceed to next step.
4. Using garden hose, spray coil vertically downward with constant stream of water at moderate pressure. Keep nozzle at a 15- to 20° angle, about 3 in. from coil face and 18 in. from tube. Spray so debris is washed out of coil and basepan.
5. Reinstall top cover and position blade.
6. Reconnect electrical power and check for proper operation.

CLEANING OUTDOOR FAN MOTOR AND BLADE

1. Remove fan motor and blade. Be careful not to bend or dent fan blade.
2. Clean motor and blade with soft brush or cloth. Be careful not to disturb balance weights on fan blade.
3. Check fan blade setscrew for tightness.
4. Reinstall fan motor and blade to top cover and check for alignment.
5. Reinstall top cover and position blade.
6. Reconnect electrical power and check for proper operation.

ELECTRICAL CONTROLS AND WIRING

1. Disconnect power to both outdoor and indoor units.
2. Check all electrical connections for tightness. Tighten all screws on electrical connections. If any connections appear to be burned or smoky, disassemble the connection, clean all parts and stripped wires, and reassemble. Use a new connector if old one is burned or corroded, and crimp tightly.
3. reconnect electrical power to indoor and outdoor units and observe unit through 1 complete operating cycle.
4. If there are any discrepancies in operating cycle, troubleshoot to find cause and correct.

REFRIGERANT CIRCUIT

1. Check refrigerant charge using the superheat method, and if low on charge, check unit for leaks using an electronic leak detector.
2. If any leaks are found, remove and reclaim or isolate charge (pumpdown) if applicable. Make necessary repairs.

3. Evacuate, recharge, and observe unit through 1 complete operating cycle.

FINAL CHECK-OUT

After the unit has been operating, the following items should be checked.

1. Check that unit operational noise is not excessive due to vibration of component, tubing, panels, etc. If present, isolate problem and correct.
2. Check to be sure caps are installed on service valves and are tight.
3. Check to be sure tools, loose parts, and debris are removed from unit.
4. Check to be sure all panels and screws are in place and tight.

Step 2—Desert and Seacoast Locations

Special consideration must be given to installation and maintenance of condensing units installed in coastal or desert locations. This is because salt and alkali content of sand adheres to aluminum fins of coil and can cause premature coil failure due to corrosion.

Preventive measures can be taken during installations, such as:

1. Locate unit on side of structure opposite prevailing winds.
2. Elevate unit to height where drifting sand cannot pile up against coil. Mounting feet, 4 in. high, are available as accessories and can be used to elevate unit.
3. Addition of coastal filter (See Product Data Digest for accessory listing).

Maintenance in desert and seacoast locations

1. Frequent inspection of coil and basepan especially after storms and/or high winds.
2. Clean coil by flushing out sand from between coil fins and out of basepan as frequently as inspection determines necessary.
3. In off season, cover with covering that allows air to circulate through but prevents sand from sifting in (such as canvas material). Do not use plastic as plastic will hold moisture possibly causing corrosion.

APPENDIX

AIR CONDITIONER AND HEAT PUMP WITH PURON®—QUICK REFERENCE GUIDE

- Puron® (R-410A) refrigerant operates at 50 percent to 70 percent higher pressures than R-22. Be sure that servicing equipment and replacement components are designed to operate with Puron®.
- Puron® refrigerant cylinders are rose colored.
- Recovery cylinder service pressure rating must be 400 psig, DOT 4BA400 or DOT BW400.
- Puron® systems should be charged with liquid refrigerant. Use a commercial type metering device in the manifold hose when charging into suction line with compressor operating..
- Manifold sets should be 700 psig high side and 180 psig low side with 550 psig low-side retard.
- Use hoses with 700 psig service pressure rating.
- Leak detectors should be designed to detect HFC refrigerant.
- Puron®, as with other HFCs, is only compatible with POE oils.
- Vacuum pumps will not remove moisture from oil.
- Only use factory specified liquid-line filter driers with rated working pressures less than 600 psig.
- Do not install a suction-line filter drier in liquid-line.
- POE oils absorb moisture rapidly. Do not expose oil to atmosphere.
- POE oils may cause damage to certain plastics and roofing materials.
- Wrap all filter driers and service valves with wet cloth when brazing.
- A factory approved, liquid-line filter drier is required on every unit.
- Do not use an R-22 TXV.
- If indoor unit is equipped with a TXV, it must be changed to a Puron® TXV.
- Never open system to atmosphere while it is under a vacuum.
- When system must be opened for service, recover refrigerant, break vacuum with dry nitrogen before opening system.
- Always replace filter drier after opening system for service.
- Do not vent Puron® into the atmosphere.
- Do not use capillary tube coils.
- Observe all **warnings, cautions, and bold** text.
- All Puron® heat pumps must have indoor TXV.
- Do not leave Puron® suction line driers in place for more than 72 hr.

Table 15—Pressure vs. Temperature Chart—Puron® (R-410A)

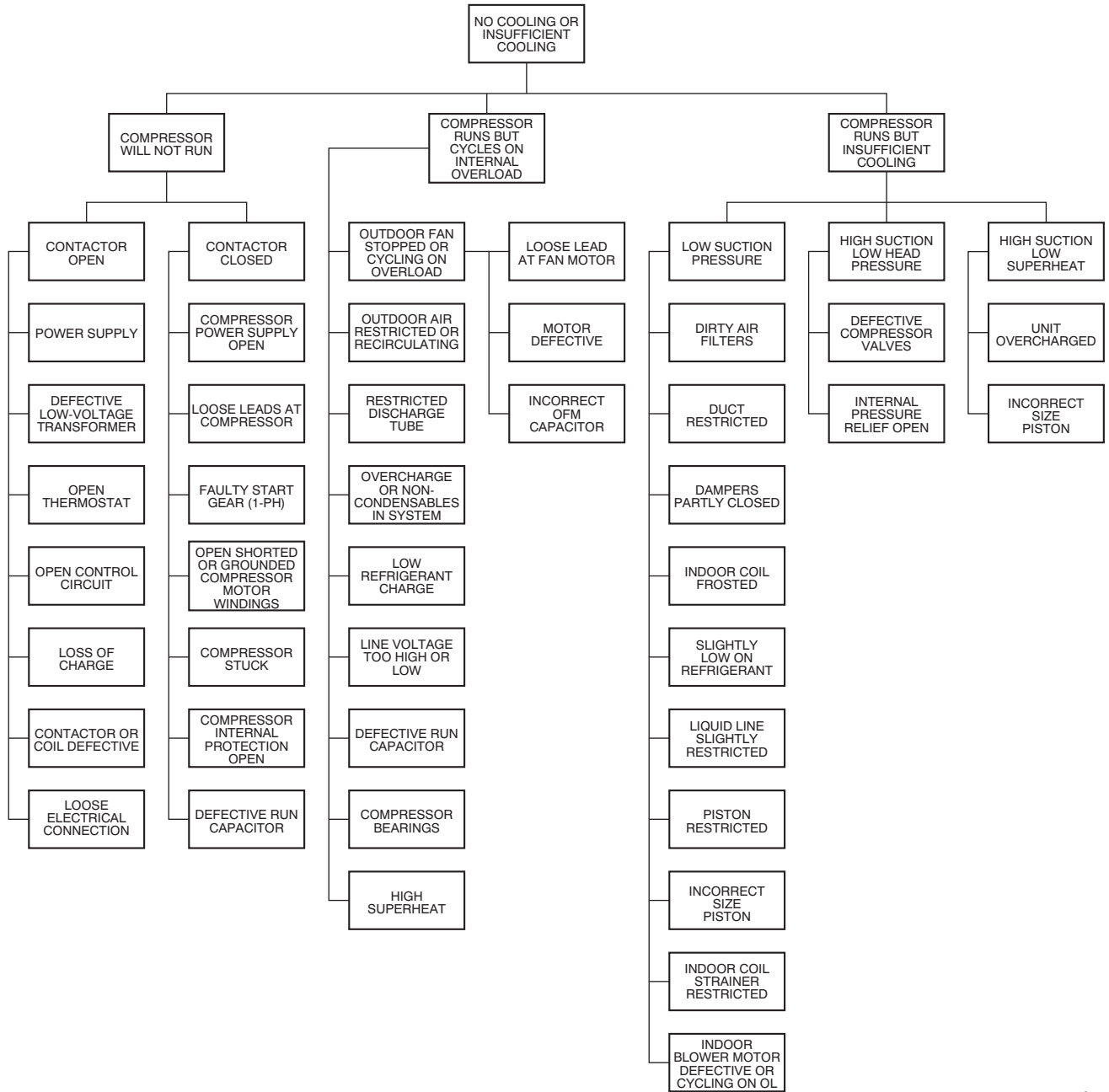
PSIG	°F	PSIG	°F	PSIG	°F	PSIG	°F	PSIG	°F	PSIG	°F
12	-37.7	114	37.8	216	74.3	318	100.2	420	120.7	522	137.6
14	-34.7	116	38.7	218	74.9	320	100.7	422	121.0	524	137.9
16	-32.0	118	39.5	220	75.5	322	101.1	424	121.4	526	138.3
18	-29.4	120	40.5	222	76.1	324	101.6	426	121.7	528	138.6
20	-26.9	122	41.3	224	76.7	326	102.0	428	122.1	530	138.9
22	-24.5	124	42.2	226	77.2	328	102.4	430	122.5	532	139.2
24	-22.2	126	43.0	228	77.8	330	102.9	432	122.8	534	139.5
26	-20.0	128	43.8	230	78.4	332	103.3	434	123.2	536	139.8
28	-17.9	130	44.7	232	78.9	334	103.7	436	123.5	538	140.1
30	-15.8	132	45.5	234	79.5	336	104.2	438	123.9	540	140.4
32	-13.8	134	46.3	236	80.0	338	104.6	440	124.2	544	141.0
34	-11.9	136	47.1	238	80.6	340	105.1	442	124.6	548	141.6
36	-10.1	138	47.9	240	81.1	342	105.4	444	124.9	552	142.1
38	-8.3	140	48.7	242	81.6	344	105.8	446	125.3	556	142.7
40	-6.5	142	49.5	244	82.2	346	106.3	448	125.6	560	143.3
42	-4.5	144	50.3	246	82.7	348	106.6	450	126.0	564	143.9
44	-3.2	146	51.1	248	83.3	350	107.1	452	126.3	568	144.5
46	-1.6	148	51.8	250	83.8	352	107.5	454	126.6	572	145.0
48	0.0	150	52.5	252	84.3	354	107.9	456	127.0	576	145.6
50	1.5	152	53.3	254	84.8	356	108.3	458	127.3	580	146.2
52	3.0	154	54.0	256	85.4	358	108.8	460	127.7	584	146.7
54	4.5	156	54.8	258	85.9	360	109.2	462	128.0	588	147.3
56	5.9	158	55.5	260	86.4	362	109.6	464	128.3	592	147.9
58	7.3	160	56.2	262	86.9	364	110.0	466	128.7	596	148.4
60	8.6	162	57.0	264	87.4	366	110.4	468	129.0	600	149.0
62	10.0	164	57.7	266	87.9	368	110.8	470	129.3	604	149.5
64	11.3	166	58.4	268	88.4	370	111.2	472	129.7	608	150.1
66	12.6	168	59.0	270	88.9	372	111.6	474	130.0	612	150.6
68	13.8	170	59.8	272	89.4	374	112.0	476	130.3	616	151.2
70	15.1	172	60.5	274	89.9	376	112.4	478	130.7	620	151.7
72	16.3	174	61.1	276	90.4	378	112.6	480	131.0	624	152.3
74	17.5	176	61.8	278	90.9	380	113.1	482	131.3	628	152.8
76	18.7	178	62.5	280	91.4	382	113.5	484	131.6	632	153.4
78	19.8	180	63.1	282	91.9	384	113.9	486	132.0	636	153.9
80	21.0	182	63.8	284	92.4	386	114.3	488	132.3	640	154.5
82	22.1	184	64.5	286	92.8	388	114.7	490	132.6	644	155.0
84	23.2	186	65.1	288	93.3	390	115.0	492	132.9	648	155.5
86	24.3	188	65.8	290	93.8	392	115.5	494	133.3	652	156.1
88	25.4	190	66.4	292	94.3	394	115.8	496	133.6	656	156.6
90	26.4	192	67.0	294	94.8	396	116.2	498	133.9	660	157.1
92	27.4	194	67.7	296	95.2	398	116.6	500	134.0	664	157.7
94	28.5	196	68.3	298	95.7	400	117.0	502	134.5	668	158.2
96	29.5	198	68.9	300	96.2	402	117.3	504	134.8	672	158.7
98	30.5	200	69.5	302	96.6	404	117.7	506	135.2	676	159.2
100	31.2	202	70.1	304	97.1	406	118.1	508	135.5	680	159.8
102	32.2	204	70.7	306	97.5	408	118.5	510	135.8	684	160.3
104	33.2	206	71.4	308	98.0	410	118.8	512	136.1	688	160.8
106	34.1	208	72.0	310	98.4	412	119.2	514	136.4	692	161.3
108	35.1	210	72.6	312	98.9	414	119.6	516	136.7	696	161.8
110	35.5	212	73.2	314	99.3	416	119.9	518	137.0		
112	36.9	214	73.8	316	99.7	418	120.3	520	137.3		

Table 16—Subcooling Charging Table

REQUIRED LIQUID LINE TEMPERATURE						
LIQUID PRESSURE AT SERVICE VALVE (PSIG)	REQUIRED SUBCOOLING TEMPERATURE (°F)					
	8	10	12	14	16	18
189	58	56	54	52	50	48
195	60	58	56	54	52	50
202	62	60	58	56	54	52
208	64	62	60	58	56	54
215	66	64	62	60	58	56
222	68	66	64	62	60	58
229	70	68	66	64	62	60
236	72	70	68	66	64	62
243	74	72	70	68	66	64
251	76	74	72	70	68	66
259	78	76	74	72	70	68
266	80	78	76	74	72	70
274	82	80	78	76	74	72
283	84	82	80	78	76	74
291	86	84	82	80	78	76
299	88	86	84	82	80	78
308	90	88	86	84	82	80
317	92	90	88	86	84	82
326	94	92	90	88	86	84
335	96	94	92	90	88	86
345	98	96	94	92	90	88
354	100	98	96	94	92	90
364	102	100	98	96	94	92
374	104	102	100	98	96	94
384	106	104	102	100	98	96
395	108	106	104	102	100	98
406	110	108	106	104	102	100
416	112	110	108	106	104	102
427	114	112	110	108	106	104
439	116	114	112	110	108	106
450	118	116	114	112	110	108
462	120	118	116	114	112	110
474	122	120	118	116	114	112
486	124	122	120	118	116	114
499	126	124	122	120	118	116
511	128	126	124	122	120	118

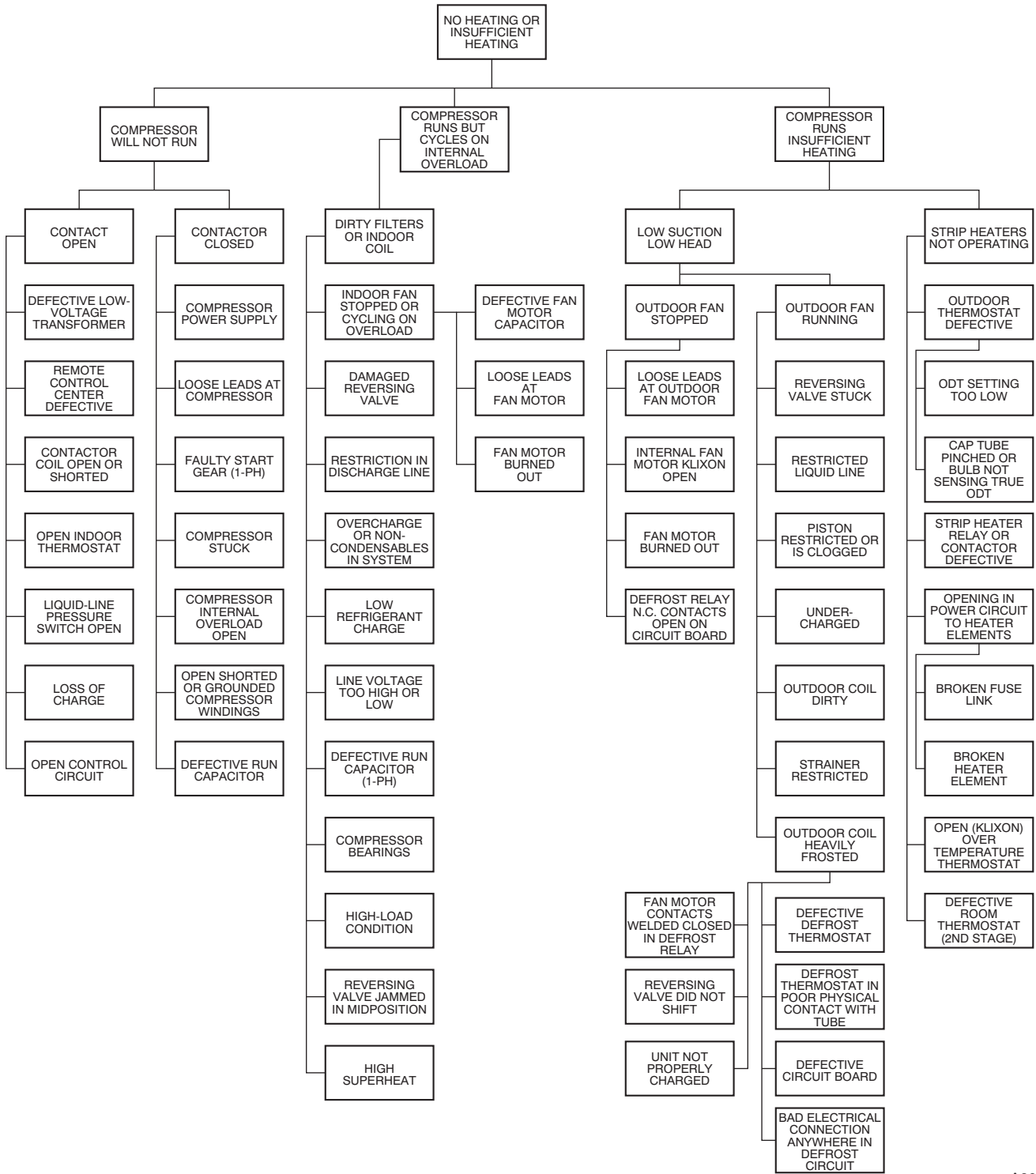
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AIR CONDITIONER TROUBLESHOOTING CHART



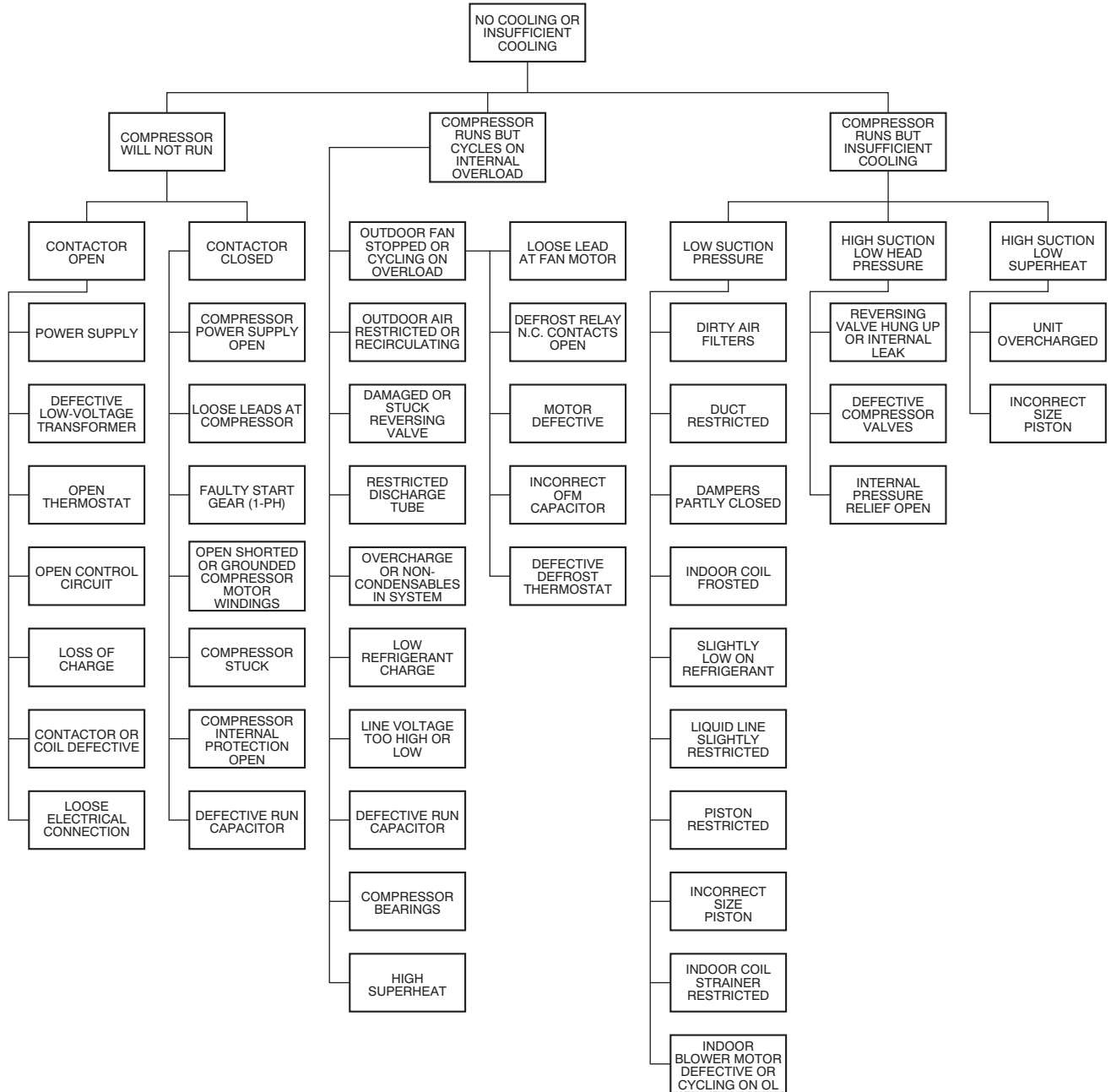
A90208

HEAT PUMP TROUBLESHOOTING HEATING CYCLE



A90206

HEAT PUMP TROUBLESHOOTING & COOLING CYCLE



A90207

Manufacturer reserves the right to discontinue, or change at any time, specifications or designs without notice and without incurring obligations.